AMERICAN DYESTUFF REPORTER

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Devoted to the practical application of dyestuffs in all industries; especially to textile chemistry—the science and practice of scouring, bleaching, dyeing and finishing.

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The Outlook For the Export Trade in American Dyestuffs

By WALDON FAWCETT

Even under the most stable conditions of commerce and world affairs, any attempt to forecast for a year to come the export movement of American dyestuffs must be in the nature of an adventure in guesswork. How much more speculative, then, must be such a hazard in appraisal when the world's markets are not only deranged because of economic influences but are likewise torn by the reactions of political strife. It is not too much to say that never before in the history of U. S. exportation of dyestuffs has there been presented a situation so complex and so difficult of analysis.

FOUR major contingencies all but baffle conjecture with respect to the near-future of the overseas consumption of American dyestuffs. The first of these is the strained situation in the Orient, involving both China and Japan, with the consequences of a boycott in the offing. Second, in the list is the crisis in India, likewise with its boycott sequel. Third, comes the indeterminable industrial potentialities of Russia. And, fourth, the unknown quantity in the Germany of tomorrow. To this sum might be added minor factors which would take major rank in normal times, as, for example, the new British tariff and Canadian resentment against the rate of U. S. exchange.

Trade must, in any event, be at the mercy of political revolution or near-revolution, but for the American dyestuffs industry the present and impending situation is particularly significant. Because it involves three of this country's best customers for dyestuffs (China, Japan and British India), our leading competitor, Germany, and, finally, Russia whose contribution to the strategy of marketing has been the subject of curiosity ever since dyestuff production was included in the Five-Year Plan and more especially since the Soviet resorted to dumping tactics. In short, Belgium is the only large-scale purchaser of American dyestuffs that does not present a gigantic question mark in 1932. And even here, as elsewhere, there hovers the riddle of the future of the gold standard.

With so much of the dye-consuming world in a state of flux, and obvious difficulties in the way of judging the future by the past, it appears that the only light upon the situation beyond the horizon may be obtained from a study of recent or current trends in dyestuff exports. To the end that the drift may be sensed, the officials of the Chemical Division of the U. S. Bureau of Foreign and Domestic Commerce have been persuaded to prepare for the REPORTER several tables designed to focus export progress down to date. Fortunately for purposes of forecast, almost all of the disturbing influences, the consequences of which are to carry over into 1932, have been sufficiently developed in 1931 to afford some indication of what effect they produce.

In providing, by way of "background," Table I, which gives the United States production of dyes by classes for the past three years, Mr. C. C. Concannon, Chief of the Chemical Division, commented for the REPORTER as follows:— "In order to give a perspective of the activities of the dye industry, I may say briefly that the American dye industry supplied approximately 94 per cent of the requirements of the United States in 1930 and, in addition, produced an exportable surplus of over 28,000,000 pounds of dyestuffs. The production in 1930 of 86,480,000 pounds of dyes represented a decrease of 22 per cent from the 111,421,505 pounds produced in 1929, when production exceeded that of any previous year in the history of the industry. In 1913 only 13 per cent of the dyes consumed were produced in this country and those were chiefly from imported intermediates."

To complete this part of the picture there are presented in Table II the imports of dyes for consumption in the

TABLE I

United States Production of Dyes by Classes

	Quantity		
	1928	1929	1930
Classes of Application	*Pounds*	*Pounds*	*Pounds*
Acid	13,469,597	14,196,815	11,457,235
Basic	5,374,099	5,899,970	4,649,898
Direct	19,633,095	21,622,907	17,553,462
Lake and spirit-soluble	1,821,492	2,724,712	2,560,936
Mordant and chrome	4,403,934	4,846,228	3,137,164
Sulphur	19,001,910	22,605,799	14,232,076
Vats (including Indigo)	32,375,812	38,784,337	32,304,300
(a) Indigo	25,861,680	29,320,270	24,326,403
(b) Other vats	6,514,132	9,464,067	7,977,897
Unclassified and special	545,512	740,737	584,929
Total	96,625,451	111,421,505	86,480,000

TABLE II

Import for consumption in the United States of colors, dyes, stains, color acids, and color bases, n.s.p.f. for 1929, 1930 and 9 months of 1931:

Year	*Quantity*	*Value*
1929	7,316,605 lbs.	$8,154,435
1930	4,939,676 lbs.	5,246,616
1930*	3,975,021 lbs.	4,388,430

*Nine months.

United States. This tabulation is the more interesting in that it embodies figures for nine months of 1931 showing the same downward trend that was so manifest in 1930. With reference to the incoming movement Mr. Concannon said: "The major portion of United States imports of synthetic dyes originate in Germany and Switzerland. As the United States is a large variety as well as quantity consumer of dyes, we are not surprised to find that our dye imports include hundreds of items, the majority, however, in small quantities. The vat dyes comprise about 40 per cent of dye imports, as compared with a domestic production of vat dyes which runs 37 per cent of our total dye production."

Bringing down to the tenth month of 1931 United States exports of dyes, colors and stains, Table III focuses the statistics covering the countries where the purchasing curve for 1932 is most difficult to chart in advance. Of the 73 countries to which the United States ships dyes, China is predominantly our best customer, taking 70 per cent in weight and 40 per cent in value of our total outgoing volume in 1930. Most of our export trade is in low-priced dyes. China in particular demands low-priced dyes as may be sensed from comparative figures. This is a factor to be reckoned with when conjecturing the possible future effect upon U. S. dye exports of a continuance and, maybe, an extension of the anti-Japanese boycott in China.

The price equation is, indeed, perhaps the one most interesting influence that may sway international trade in dyestuffs in 1932. Because we have China and certain other countries more than ever responsive to price competition at the very moment when Germany's future policies on pricing are at the crossroads. In a report covering the third quarter of 1931, the German Dye Trust states that the turnover in dyes showed every little change as against the previous quarter. Certain declines in trade with various European countries were, it is worthy of emphasis, balanced by seasonal increases in overseas trade. It is well known that the German industry, in a determination to obtain the utmost slice of the international trade, has gone to the limit, on occasion, in shading prices for overseas delivery. Some onlookers have asked themselves whether this policy would be continued should the German Government be reorganized. In answer, one school of thought holds that a Fascist government in Germany would be, if anything, more resolute in determination to capture as much of the world trade as possible.

Russian imports of dyes from the United States continued so small for the first six months of 1931 that it remains as conjectural as ever whether and to what extent Soviet Russia will develop as an outlet for American products. What is more intriguing as a subject of debate is the part which Russia is to play in supplying dyes to the outside world. Figures on Russian production have been slow in coming through. Only a few weeks ago there was received in Washington the statement for the fiscal year ending in September, 1930. This shows, for 1929-30 a production of 15,911 metric tons, as compared with an output of 12,643 metric tons in 1928-29. A seemingly safe assumption is that "dumping" in outside markets is a distant possibility if Soviet Russia is to first supply the dye requirements of her own industries.

Because the situation in British India, hingeing as it does upon the future course of Ghandi and his followers, is the most delicate of all the liabilities to be discounted when computing dyestuffs expectations, Table IV is suggestive. This muster reveals to what an extent the German dye producers dominate this market and, since dominance is dependent upon price, reveals, in inference, what readjustments might follow in the Indian market should a change in German political policies be followed by revision of industrial policies. Certain specialists on Indian trade do not hesitate to predict that if Ghandi's original program should be resurrected and prevail to an increased degree it would operate to bring about a reduction of all dye imports into India.

Worthy to rank with the Indian enigma as a puzzle for 1932 is the measure introduced into the British Parliament on November 13 providing for the extension of the

(*Continued on page* 69)

Proceedings of the American Association of Textile Chemists and Colorists

The American Association of Textile Chemists and Colorists

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CALENDAR OF COMING EVENTS

Council and Research Committee Meeting, Chemists' Club, New York, January 22nd.

* * *

Meeting New York Section, January 22nd.

* * *

Meeting Northern New England Section, February 6th.

ELEVENTH ANNUAL MEETING CONTINUED

Note: Other reports of the Annual Meeting appeared in the Jan. 4th issue of the Reporter.

Friday Evening Session

December 4, 1931

The Eleventh Annual Meeting of the American Association of Textile Chemists and Colorists convened at seven forty-five o'clock at the Hotel Statler, Boston, Massachusetts. The meeting was opened by Mr. H. R. Davies, General Chairman of the Northern New England Section Annual Meeting Committees.

Mr. Davies: On behalf of the Northern New England Section, I want to welcome you all to Boston and express our appreciation for the excellent turn-out. It is a source of extreme satisfaction to see so many present here tonight.

As Chairman of the Committee on General Arrangements I want to bid you all welcome and before starting the serious program of the evening which is to be taken care of by Mr. Cady, our Vice-President, I should like to have you listen to a few selections by the quartet we have here to entertain you.

. . . Selections by the quartet . . .

Mr. Davies: Now I want to introduce Mr. Cady, your Vice-President, who will take charge of the serious part of the evening's proceedings. Mr. Cady! (Applause.)

Chairman Cady: Gentlemen, the first item on the technical program this evening is on a subject that should be of vital interest to everyone who is interested in dyes. I refer to the subject of color blindness. We have with us this evening Dr. Edward M. Smith, the plant physician of the Arlington Mills, of Lawrence, Massachuetts, who has made a special study of accident prevention and also of the whole subject of color blindness and he will talk to us on that subject. I am glad to introduce Dr. Smith.

Proceedings of the American Association of Textile Chemists and Colorists

Tests For Color Blindness

By **DR. E. M. SMITH**
Arlington Mills

GENTLEMEN of this very large audience: When I was asked by one of your fellows, Mr. Hugh Christison, of our mill, to talk before a small informal group upon some of our interesting and rather amateur understandings of color blindness I had no notion that I would have to appear before so large and so intelligent an audience. I feel the weight of both of those words. I am not used to speaking in public and have not done so for some time.

I wish you to understand very directly at once that I am not a professor of ophthalmology nor a specialist on this subject. My apology for appearing before you is that the subject deserves your attention; and there are new ways which have been discovered for testing color blindness; and that I am myself somewhat color blind and will substitute for a victim in showing you various color blind reactions. I have the usual defect of slight red blindness—not an extreme case.

I think it is useful to you gentlemen to have a primary understanding of the subject and probably there are many of you who have a great deal better understanding of it than I have. I want you to know that it is of some practical importance in your work because the incidence is higher than we used to think it was. With the old Holmgren Wool skein tests the average findings were around four per cent at most. With the new tests which we will show you tonight, some of the newer and more delicate tests, the percentage is very regularly and uniformly one in twelve which means that one in twelve of your employees has a serious defect in receiving color and that one in twelve even of those working for long periods of time with color may indeed still have the defect. Only careful testing will reveal the defect which goes on unsuspected. Meanwhile disagreements about matching continue because of "different eyes." We have evidence that this is common and important. There is need for the best testing in all textile schools and in practical mill work. *Disagreements in color matching, even among trained experts, should always be thought of as possibly "different eyes by test."*

This "one in twelve" holds only for men, yet the percentage for women has been found to rise too to at least one and a half per cent. So that women with color blindness are by no means extremely rare now.

My own interest in this subject was stimulated by finding this new test and by applying it in the examination of a group of workmen in the Arlington Mill in April of this year.

I examined one hundred and fifty-seven consecutive workmen coming into a textile mill and found the usual 8.2 per cent, or thirteen color blind individuals in that group. One in a dozen is a matter therefore of some practical moment to you men who are working with practical things. Less than half have any suspicion of the defect even if you are examining university men.

The test that we will show you is the Ishihara test for color blindness which was put out by Professor Ishihara of the University of Tokio and which is a series of colored plates which are read by the normal eye and which are seen somewhat differently by the color blind eye. They are extremely ingenious and the color inferences from them are rather fascinating. Eyes see different colors.

One of your members, Mr. Christison, has very ingeniously I think thought up and by careful work with color photography has made slides to present to you tonight, a number of those Ishihara charts.

We will start with a brief explanation of the mechanism of receiving color. My explanation is very crude but it will give a popular notion and a more accurate approach to an understanding of these interesting slides.

In a survey of color blindness Jeanette Clark, for the United States Public Health Service, has said that a single one of these charts is more revealing of the defect than all the other color tests commonly used put together.

My subject, I notice, was printed as "Tests for Color Blindness." I shall not speak tonight of any other test besides this one, which seems new, interesting, and practical.

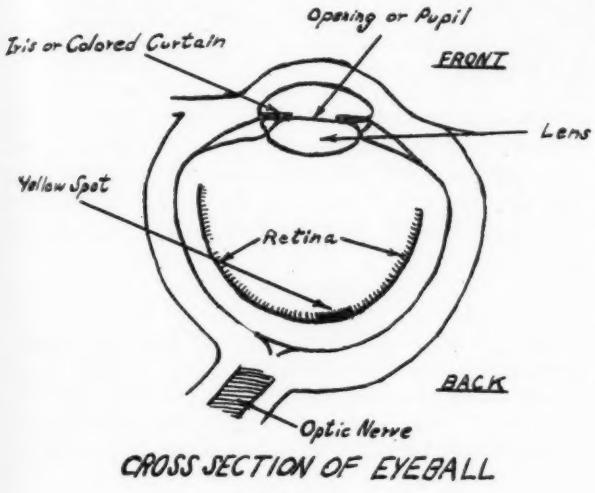
Slide No. 1

This little diagram which is tremendously crude is just a representation of the human eye. You will see at once that the "looking" part of the eye is upward on the board there. Then you see the lens, you see the colored curtains which are the colored portion in front of the eye. Here you see the retina in a cross-section of the eye.

I call to your attention the yellow spot on the back of the retina here and the entrance of the optic nerve back there. It is called yellow because it appears yellow and not because it sees yellow, which, however, it does.

Slide No. 2

We have looked through the pupil and we are now seeing the retina as one glances upon it. Very plainly in front are seen the blood vessels branching out from the entrance of the optic nerve which is there.

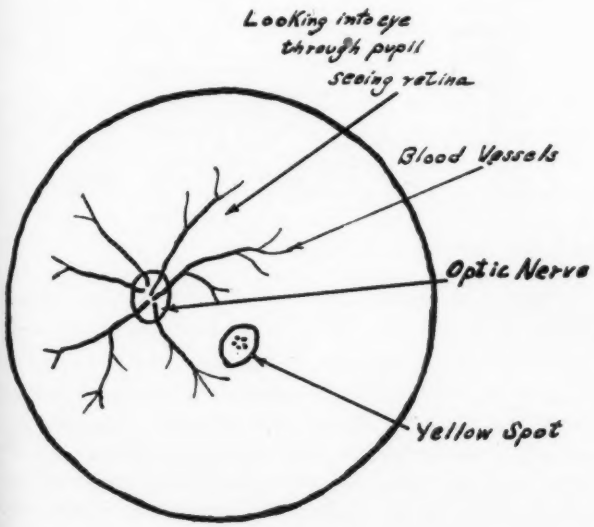


Slide No. 1

Again I call to your attention the yellow spot in rather the center of the eye and wish you to bear in mind its location.

SLIDE NO. 3

Here we have a very crude diagram of the two kinds of vision. Indeed there are three. There is night vision or peering vision—what I would call "owl" vision. There is daytime "black and white" vision and then there is color vision.



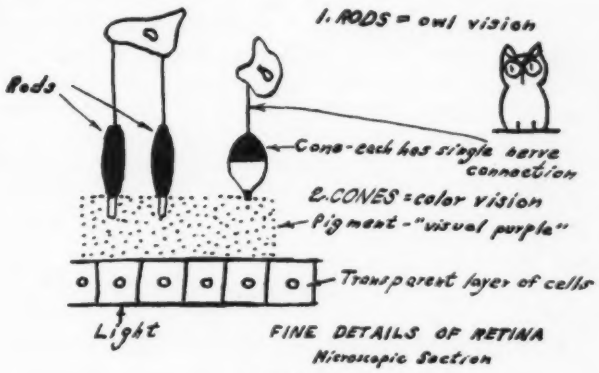
Slide No. 2

These two elements are the fine elements of "black and white" vision. They are called the rods. This is a microscopic section of the retina, on the front of it a group of cells, you see, which are transparent and transmit light back through a layer of pigment which is visual purple and which light will bleach. Visual purple extends up between the rods, acting as kind of a camera chamber for those fine elements.

Notice that I have connected two of them together to a cell which shows that they do not have an individual direct connection with the brain, in contradistinction to the other element which is the cone, which has a single connection with a single cell and a direct connection with the brain, each individual one.

The cones are much larger and are the mechanism which convey color, and which apparently receive color.

The yellow spot that I spoke to you about a minute ago has no rods in it or practically none. It is therefore true that at night you see things by not looking at them. You see them out of the corner of you eye so image falls on "rod" areas. You see them on the other parts of the retina besides the yellow spot. On the other hand, the cones are massed there and that is the spot of maximum vision for color.



Slide No. 3

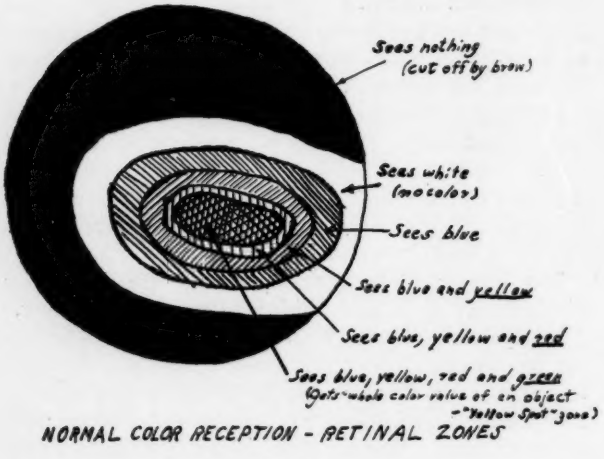
I said that the rods equal "owl" vision and it is really true that owls have nothing else than rods in their eyes. That is just a fine microscopic notion of how the eye receives both light, black and white, and color.

These are very crude diagrams for which I must apologize. If I had thought this meeting was going to be as large as it is I would have made them much better. (Laughter.) I really mean that.

SLIDE NO. 4

We have here a chart of how the retina receives. This is the normal retina or color receiving screen.

I want you to understand that in looking out at things you can't see a complete circle on account of the brow here, and all of this section is cut off from a complete circle. This is a chart of vision for the right eye. Nothing is seen in there. You see only white here. Here it is possible to see blue only, while in the center of the eye up there you gain the capacity to see green. Outside that is a range for red.


Sees nothing
(cut off by iris)
Sees white
(no color)
Sees blue
Sees blue and yellow
Sees blue, yellow and red
Sees blue, yellow, red and green
(Gets whole color value of an object
- "Yellow Spot" goes)
NORMAL COLOR RECEPTION - RETINAL ZONES

Slide No. 4

I wish you to understand that all of the colors may be seen in the very center which, of course, includes the yellow spot that I have spoken about. As one goes farther out some of the colors drop out and cannot be seen. For instance, if one gradually comes around to a rainbow the first color that will be seen will be blue because the image will fall on the side part of the retina. As one comes further around he will be able to see yellow and then red and green, and finally all of the colors. But this gives you some idea of the areas of sensation which the normal eye has.

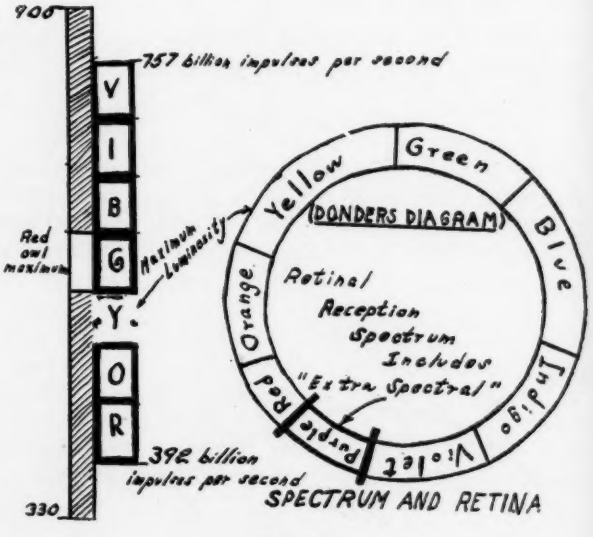
SLIDE No. 5

Here we have the color receiving apparatus or screen of the color blind individual, diagrams of which were drawn. That individual has a tremendous zone on the side of eye-cup, as it were, with which to see white; his blue zone is markedly restricted; his red zone is very small; and his green is very fine indeed. So that the color blind individual we frequently will find will see color but will have to look at it extremely directly, look it "up and down."

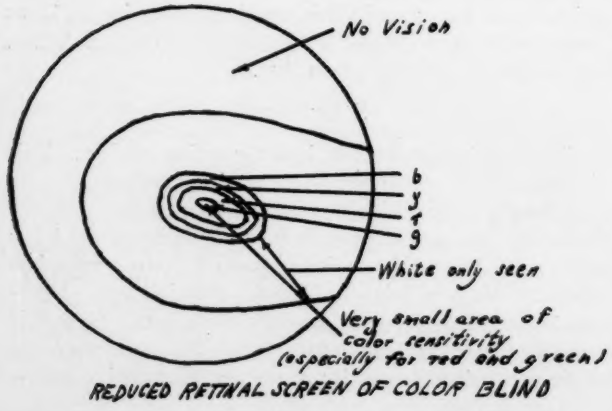
For instance, I will pass red and green lights on the ordinary highway if they don't occur in my direct line of vision yet I will tell you instantly if I look at them that they are red or green because that image is in its correct place in the very center of the eye.

SLIDE No. 6

There is your spectrum. Most of you are probably habituated to think of colors as residing entirely in the spectrum. A good definition of color for us to work with is that color is a sensation derived from the reception on a retina of light of various wavelengths. But what I want you to see tonight is that color varies because retinas vary and that one in twelve individual has a variable retina.



Slide No. 6



Slide No. 5

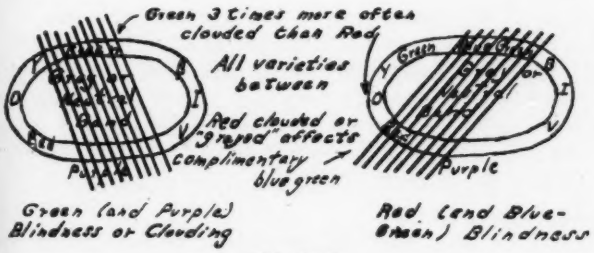
Here I have drawn just crudely the normal spectrum giving impulses from about 392 billion to about 757 per second, which would be received by the retina. I have drawn in here just for your information the spectrum which would be seen by the color blind eye of an owl. It extends farther back than the normal spectrum. This would show just as light. For instance, if an owl looks at a rainbow he will see light from an area below red to above violet, a longer range, not colored at all. The maximum intensity will occur in the green zone whereas in the normally visioned individual the maximum intensity occurs in the yellow zone, as I have shown.

It is well to remember that that is the spectrum, that is outside the eye, and this is a better diagram of the retinal reception spectrum, I would call it, or cone reception spectrum, because that is the apparatus used in final detail. Notice this includes the extra-spectral color, purple. Purple as you will see later on in dealing with the color blind acts exactly as a complement to certain greens.

I will just give you a preliminary conception of what color blind people are like.

SLIDE No. 7

Here we have the commoner form of green blindness. It is as though that diagram of the way the eye sees the spectrum were pulled in half. There you have red, orange, yellow, green up there, and over there blue, indigo, violet, and purple. In the color blind individual there is a wide zone between those halves of the spectrum which is occupied by a grey or neutral band. It is as though that eye were furnished with a grey band which it mixes with the pigments that sunlight or your materials show them.


Green 3 times more often clouded than Red
All varieties between
Red clouded or "greyed" effects
complimentary blue green
Purple
Green (and Purple) Blindness or Clouding
Red (and Blue-Green) Blindness

Slide No. 7

The grey band as you will notice goes over the green and comes close to the blue. It also extends into the complementary purple which I have spoken of.

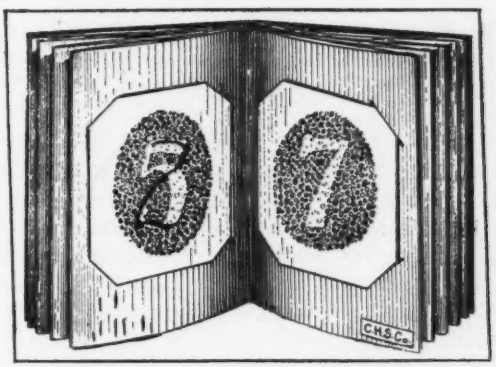
The interesting thing, of course, in varieties of color blindness is how wide those bands are. Sometimes they are indeed so wide that only yellow and blue are left to the eye for reception. The rest of the spectrum is color blind or clouded. A few men have only a grey sensation, no colors at all.

In this chart I have drawn the other variety, the red blindness. You notice that I have given rather full terminology: Green and purple blindness, or clouding—there you must think always of the complementary colors because those people will miss the purples that are complementary to the greens. In the other variety the distortion is represented by this diagram which I have made and the grey or neutral band occurs in the blue greens, toward the blue side this time, and may cut off or shorten the red end of the spectrum considerably in its reception, or may cloud it and make it grey.

Once again, that may be so wide as to leave the individual with only yellow and blue vision. Notice again that we have called this red clouding and blue green clouding blindness. As we show the charts you can almost see that as the charts are put before you.

SLIDE No. 8

This very last one I will leave on the board when we get through just for your interest, to show you that the



Tests for Color Blindness
DR S. ISHIHARA

Frequency of Color Blindness 1 in 12 males

Von Planta examined 2000, found 159	= 7.9%
Miles (entering men at Stanford-1286) 106	= 8.2%
Haupt (Johns Hopkins-448) 35	= 7.8%
Smith (Arlington Mills-157) 13	= 8.2%

Less than half suspect any defect (even univ. men)

Women 900 about	1%
Indians 1000	1.7% (males)
Negroes 300	3.7% (")

One in a dozen men will match colors badly

Slide No. 8

work with this particular test has been rather completely gone over by investigators at different universities. I included my own findings to show that it runs absolutely uniform with the findings of others.

Notice that among females only between one and two per cent are color blind. Yet you can find color blind individuals among the females.

Notice the racial differences which are interesting, Indians lower than Negroes, Negroes lower than whites.

This is the test that we have spoken of and it is available through Stoltting Company of Chicago or Mahady Co. in Boston. It isn't in very common use.

Now we will have the slides which have been prepared for you. These slides which you are going to be shown are representations for use before an audience of the Ishihara charts. Not all of them are shown. There are

sixteen of them. The basis of these charts is that the normal eye will see a different figure in these charts than the color blind eye. A great deal of ingenuity has been shown in devising these charts, making luminosity in color and hue just exactly correct, so that a distinction can be made between these two groups of eyes.

As I said these charts are regarded by Jeanette Clark as more valuable than the other color blind tests which have been devised.

SLIDE No. 9*

I am going to tell you exactly what I see in the chart. I am going to use Christison to get him to tell me what he sees in this chart.

Mr. Christison: I see a "5."

Dr. Smith: I should have spoken first but I was uncertain about our lighting. I don't see anything there. I don't see any figure at all. Have you the green screen there so as to show the audience that there actually is a "5" in that chart? I don't want anyone to give himself away. I expect there are a few color blind individuals here. This is color testing on a large scale, as possibilities for school use.

Will you slip one of the other slides in?

Mr. Christison: Just a minute. I must explain that these slides are so dense, because of the photographic process, that they heat very rapidly and we can only leave them in the lantern for about fifteen or twenty seconds at a time. If they are left in longer than fifteen or twenty seconds the starch granules that they are composed of start to chalk. I can put them back and forth as many times as I want but we will have to let them cool off a little bit in between times. The ordinary slides are thin and they pass through without generating any heat.

Dr. Smith: Of course, I might tell you that there is a "5" there. You will see a colored number among those spots, of quite a large design. We will show that slide again after showing one of the others.

This shows you that the color blind eye which I represent at this time does not see what the rest of you see: a colored "5." I can't tell you what color that is in except by reference to my notes.

SLIDE No. 10*

I hear a great many say "74," but I see only "21." (Laughter.) You may not believe me, except those of you who are seeing 21 with me. These charts are extremely ingenious. In the other chart I missed something that you saw. In this chart it is evident that I am seeing something that you don't see. The bar in the "4" I see but the "7" which you saw plainly has a tail on it to make a "2" for me.

By adjusting colors and luminosities Ishihara has made it so that I see a "21" in dull violet and blue where you are seeing a "74" in green, is it?

You will remember I said that I was red blind but most color blind people are color blind through a whole zone and it touches the green zone. I cannot see that "74." We tried to make a filter so as to make it plain to you that that "21" is there but we were not able to get the difference by filter so I cannot demonstrate that to you.

Dr. Walter M. Scott: It might be interesting if you asked whether anyone else in the room sees that "21."

Dr. Smith: I dont' want them to give themselves away.† (Laughter.) I know it is there. I see it very plainly. The other charts are based on different principles.

SLIDE No. 11*

All of you probably or most of you are seeing an "8" here. I see only a "3" because that "8" has been completed in a color which I do not see. So that in reading that chart the normal eye at once says that is an "8" but the eye that has a retina such as I have sees only "3" there and you can see how easy it is to have that deception. I will explain to you a little further along why it is that appears to me as a "3" and as an "8" to you.

We have another chart which distinguishes between the two kinds of color blindness and in this chart you will see, yourselves, that numbers are present which I deny. Do most of you see a "26" there? I see only the "6." That means I don't see the red there which is probably very plain to you.

On the other hand, the green blind person will see the "2" only and read that chart as having only a "2" in it and fail to see the "6." One of my messenger boys sees only "2."

We run into an interesting thing here: that the "6" is in dull violets and purples, so that you are testing for green blindness by using the complementary color which is purple. Really, what you were testing here for was purple blindness and yet at the same time, by finding an individual who does not see purple, we know he does not see green. Ishihara has used that method of discovering it.

SLIDE No. 12*

Here is rather the prize slide. Does anyone see a figure in that at all? No one sees a figure but me. Well, that is very, very hopeful for this audience. This is an interesting chart because I see a "5" in that very plainly and this is most curious: that I see it in rather red colors, a rose color, a sort of rose violet we will say. It has a distinct red element in it and the color is very plain and the figure is very plain to me, a large "5" right up there. (Laughter.) I think you will have to take my word for it.

* Slides Nos. 9 to 13, inclusive, were highly colored slides which were not conveniently reproducible for black and white printing.

†Color blindness was present in the audience as revealed after the talk. One case was totally color blind, could see no numbers on any Ishihara chart.

From some of the things I have been showing, you will see what a wide difference there is between the normal individual and the color blind individual. We are not so fortunate as to be able to show you a chart in which we can reveal both sets of numbers. It is true that there are very superior eyes which in the daytime apparently see both types of numbers, both what the color blind individual sees and what the normal individual sees.

I just want to explain the principle upon which such charts are made.

You remember perhaps that chart in which you say you saw "8" and in which I said I saw only the "3," part of the "8." In this chart the concealed "3" and "5" are seen by the elimination of terra cotta spots, that is, dull red spots. There is an olive green background with terra cotta among it. The color blind eye sees against that background a dull violet and blue green number. That dull violet and blue green blend in with the background on your case and you see only a bright green number against such a background which you see as "74."

You will perhaps remember the chart in which you saw no number and in which I saw "5." In that chart the color blind eye is confused by dull yellow and dull violet with a background of blue green figures. I think perhaps the explanation ought to have been made when we were showing those charts.

Christison, will you show 21-74 again? I am going to stop in just about a second and ask if there are any questions or any way in which we can make this matter clearer or more interesting.

SLIDE No. 13*

This is the 21-74 chart here which you are looking at. There is a concealed "21" there which is seen by the elimination of olive green spots. The confusion comes because of a terra cotta background with olive green among those spots. The color blind eye picks out a dull violet and blue green number from among that background.

Before I say anything further I want to ask if there are any questions that occur to you about these charts that I have presented. You can appreciate the extreme ingenuity involved in producing them.

Mr. George A. Moran: What is the difference between the two "74" charts? Do both of those show "21" to the color blind eye?

Dr. Smith: Yes, both of those will show "21" to the color blind. One is slightly denser than the other.

I just want to say a few words more to make sure that I covered the very few points that I really wanted to cover here tonight

In remembering this green blind and red blind anomaly I want you to remember that there are three times as many green blind as there are red blind and that this is not an absolute blindness but a clouding or greying of a wide zone of color in the green and blue green region which extends into the complementary purples, giving a wide zone of defect in color receptions.

I want to again present the fact to you that half of all color blind people are absolutely unaware of their defection, so that you will find them everywhere. Only half of them at the very most have any suspicion that they have this very important defect. They will go on as people will in music, thinking that they will improve from time to time when they have an absolute limitation upon what is possible for them.

The condition, as perhaps you are all aware, is inherited. It is inherited along the same lines that bleeder's disease is inherited That is, the Queen of Spain has given bleeder's disease to her sons. It would then be transmitted by females of that line to their sons. In other words, you would expect my uncles to be color blind, as they are. My mother gave me the defect, without my sisters having it. That is how the inheritance feature of it works out. It is "matrilineal."

There is no correction for it. Colored lenses will not make up for a grey zone.

I want you to think of it not as being an isolated and strict defect, but as a defect of wide variety so that some see only the yellow and blue among the colors and the rest is all grey for them.[11]

The thing that is scientifically interesting for you to bear in mind is that change in luminosity for the color blind may mean a change in color. You see, they have a wide zone of neutral grey in there which changes their luminosity as they see colors. If you change the luminosity on a blue green for a color blind individual you may change the color entirely. A change in luminosity then will make an entire change in color.

I want you to keep in the back of your head the fact that this is not an isolated defect, that there are probably minor defects of a similar character very much more widespread, and perhaps in other zones. By that I mean that even such things as racial differences may have an effect. For instance, a Norse ideal of blue is certainly not the Jewish idea. There are vast differences in retinae.

One last interesting scientific thing for you to remember is that the human retina is derived from the skin. The skin and the retina both grow up together. They start in a common kind of tissue. Therefore one might almost think that the pigment of the retina would bear some relation to complexion, and there is some truth possibly in that. I have been able four times to pick out individuals who were color blind just by the makeup and complexion of those individuals. I have been correct in predicting it at least four times in just a small group of cases. I don't wish you to think that we have just dealt with 13 cases because we have more than 30 cases available.

That is all I had to say.

[11] Case in audience "all grey."

Discussion

Dr. Walter M. Scott: Doctor, I have noticed a certain type of what might be called color blindness which is not quite as pronounced as this red green but in my textile work I have come in contact with certain individuals that apparently see colors (this is the only way I can express it) under artificial light, that is under strongly yellow illumination as most individuals see those colors under daylight, that is, under a more neutral or bluish illumination of north sky. Where we are dealing with dyestuffs which show a distinct marked change under different illuminations I have found that there are some individuals who see those colors under daylight just as most of the people would see them under artificial light; that is, they seem to be sort of reversed.

I don't know whether you have ever come in contact with such a form of color blindness or whether anybody else has noticed it. I just bring it up as a matter of interest.

Dr. Smith: There is a good deal of interest to that I think. For instance, in my own case under ordinary yellow light I see red, at night, because a red of low visibility becomes orange on account of the large amount of yellow which is in ordinary artificial illumination, so that red becomes increasingly visible by becoming increasingly orange. They move up in yellow content at night.

I am just going to spread out this chart to give you a glimpse of the sort of thing it is. It can be very quickly run through and the numbers which are seen can be rapidly put down on any kind of form. We have devised a little one on which to put down what numbers were seen. Individuals can be tested at the rate of twenty-five an hour, by just simply putting this up on a wall. They look at it at a distance of three feet and then they just write down what they see.

The important part of this test is there is no naming of colors. They just simply look at it and write down what they see.

Are there any other questions?

Question: I would like to ask if normal color vision is affected by fatigue. Does a tired man with normal color vision become color blind?

Dr. Smith: It is interesting to note that color blindness does occur and is apparently a part of general fatigue. It is true that the tired color blind individual has a much higher degree of color blindness than the normal individual and it is also true that ordinary fatigue does diminish the color sensation.

Another interesting thing is that about the only way you can get this kind of color blindness without inheriting it is by extreme tobacco smoking. Tobacco smoking seems to affect the red and green elements in vision and I am rather under the impression that if one looked far enough he would find mistakes in matching after extreme cigar smoking as after "lunch" in a mill. (Laughter and applause.)

Chairman Cady: For the benefit of any of those present who may be non-technical we will now listen to a selection by the quartette.

. . . Selection by the quartette . . . (Applause.)

Chairman Cady: Gentlemen, please come to order. We have asked Mr. John G. Masson of the Rosemont Mill, Woonsocket, R. I., to prepare a series of questions on practical problems in wool dyeing and we have asked Dr. E. W. Pierce, of the Ciba Company, to prepare the answers to these questions. I am going to ask Mr. Masson and Dr. Pierce to come forward please. (Applause.)

Practical Problems of Wool Dyeing

By **JOHN G. MASSON[1] and E. W. PIERCE[2]**

MR. JOHN G. MASSON: Well, gentlemen, I understand that some of you expect me to make a speech but that is asking a little bit too much from me. I will just propound the questions to Dr. Pierce and I hope that will lead to discussion and that some of you will be kind enough to express yourselves and perhaps reply to the questions at the same time.

This is the first question:

With a few exceptions on very pale shades, it is common practice to color wool at the boil. This temperature of close to 210 is highly detrimental to the tensile properties of the fiber. Is there any record of research made with the intention of lowering the temperature, retaining, of course, the properties of the dyeing as far as fastness to light and fulling are concerned?

I give you as an example any Acid Chrome color like Erio Chrome Azurol or even Diamond Black, which is dyed on wool with acetic acid, boiled thirty minutes, and then after-chromed with a certain amount of chrome, and boiled again for thirty minutes. So we have here sixty minutes of boiling at a temperature of around 210 and anyone in wool dyeing knows very well that a temperature of 210 spoils the tensile strength from 40 to 60 per cent.

That means that a white skein of yarn which shows 100 on a Scott Tensile Strength Tester, after it has been boiled will show from 40 to 60, according to the amount of time it has been boiled.

That is the question.

[1] Rosemont Mill, Woonsocket, R. I.

[2] Ciba Company.

Dr. E. W. Pierce: I am so glad that this is an informal occasion and not seriously formal.

When I read the three questions that Mr. Masson had prepared for me I though instantly of a little story I read in a New York newspaper once. You will pardon this digression but it will show you the point.

It seems there was a great criminal lawyer in New York who only defended criminals, generally guilty criminals, and he was always successful, with the exception of one occasion. A tailor had had his shop robbed and a man had been arrested on circumstantial evidence and was on trial.

This criminal lawyer pointed his finger at the little witness, the owner of the shop, and said, "Tell this court how it would have been possible for your shop to be robbed if when you left your shop on Saturday night you locked the windows and doors." He said, "How could that have happened?"

The fellow said, "You ask me. I am only a tailor. Ask your client. He is a burglar." (Laughter.)

So we have Mr. Masson, probably one of the best authorities on wool dyeing in the country, asking me questions. I will try to answer him, however. (Laughter.)

I have no record nor have I seen any research that boiling wool in a simple acid bath at 212 degrees Fahrenheit for one, two, or three hours injures the tensile strength of the wool. All of the occasions on which wool tendered have generally been due to the action of alkalis in scouring or the action, as is probably true in this case, of chrome acid. Chrome acid is the thing that will work great detriment to the wool fiber in every case.

To cite an example: About three months ago I was sent for by one of our customers who dyes a large quantity of a fine knitting yarn he sells to a concern that makes bathing suits and athletic goods. We went into the place. The boss knitter knew nothing whatever about dyestuffs. He said to me, "There must be a difference in these dyes. You take these colors and they feel the same and when you put certain colors on the machine they knit perfectly, but when you take this black and this blue they seem to throw off fibers; they clog up the needles and they break a great deal."

I made inquiries of the dyer who was doing them. He said, "That blue is an after-chromed blue and that black is an after-chromed black but the other colors are neutral dyeing colors and acid colors and have not got the chrome in them, although there is no difference perceptible to the touch."

The effect of that small amount of chroming which was only one per cent, was that it had deteriorated the yarn.

I think in this particular instance it is the action of the chrome that is causing the tendering rather than the action of the sulphuric acid or acetic acid and the boiling temperature.

On the other hand, that can be gotten around. There have been developed in recent years a series of dyestuffs which are really chrome dyestuffs but instead of the chrome being in the form of chromic acid the dye and the chromium are combined to form a soluble compound. The chrome is in the form of chromite. So that when the dye is in the presence of a large amount of acid it decomposes and precipitates in the wool fiber and further dyeing unites the coloring matter with the mordant and produces a chormium lake on and in the fiber without any deterioration of the wool.

Such colors have been used successfully for many years and I think will overcome the difficulties that Mr. Masson has suggested. But I would be very glad to hear from any of you who know of an instance where simply boiling in sulphuric acid and water deteriorates a wool fiber, providing there is no chromic acid present.

I think that is about all I can say on the matter. We are open for discussion on that.

Mr. Masson: May I say a word?

Tests have been made on different skeins of worsted yarn of the same length, boiling in pure water, water and ammonia, water and acetic or formic or sulphuric acid, and the worst action has been produced by water alone, which deteriorates the yarn to the extent of forty to sixty per cent. When you use an acid it is not so bad and I should say that sulphuric acid is the best. That is the one which preserves the wool best. But anyway, it does lose some strength, which means that whether the dye is chromed or not, whether it is neutral or acid, as far as I can see it is the high temperature of the water which is doing that.

Dr. Pierce: Yes. I think it would be more reasonable to assume that pure water, or water and ammonia, would deteriorate the wool more than a strongly acid solution.

Mr. Masson: And a large amount of sulphuric acid is better than a small amount.

Dr. Pierce: I am glad to hear you say that.

Mr. Masson: Anyone of us thinks that when we go over four per cent of sulphuric in a bath it may be bad for the wool but that is not true. Ten per cent of sulphuric is less injurious than a smaller amount.

Dr. Pierce: We have the instance of carbonizing the wool, where it receives eight or nine per cent of sulphuric acid, and then is dried at a high temperature and I have never heard of a case where the wool has suffered greatly by that operation.

Mr. Masson: Maybe some of the gentlemen present have had experience coloring wool below that point, below 210 or 212.

Dr. Harold C. Chapin: In 1927 I presented before the Northern New England Section a paper which was published later in the February 7 number of the AMERICAN DYESTUFF REPORTER on some experiments which we performed at the Lowell Textile Institute.

We held wool yarn skeins in a thermostat for three

hours at a temperature of about 120 degrees Fahrenheit, some of these skeins in water, some in alkaline solutions of various concentrations, some in soap solutions. We proved that in water alone at 120 degrees Fahrenheit, for a period of three hours, there is distinct deterioration in strength of fiber.

Weakening of fiber, we had found in earlier experiments, may not be revealed clearly by tests on dry yarn; perhaps because the raising of scales and consequent roughening of fiber surface, which goes with fiber weakening, may cause friction between fibers, and so a compensating strength in the yarn as a whole.

If, however, one tests the wool in moist condition, rather an unusual method of testing, to be sure, but a particularly interesting one in this case, then the scales, raised though they may be, nevertheless slip upon one another. One measures then the full weakening effect produced in the fiber. In wool so tested the weakening effect produced by water at 120 degrees is marked. It must be very much greater I should say in water at the boiling point.

Dr. Pierce: I wouldn't be willing to admit that test of trying the wool when it is wet. It is a well known fact that all fibers when thoroughly saturated with water increases in elasticity and lose in tensile strength, such as rayon, silk, and things of that sort. If the wool is weak when it is wet and regains its strength when it is dry we have a right to believe that the manufactured material, which is worn dry, will have that full strength, and I wouldn't call that a deterioration if it was only a temporary effect while the wool fiber was wet.

Dr. Chapin: We checked everything against reference standards; that is, we compared the effect on a skein soaked in cold water with the effect on a skein soaked in warm water.

Dr. Pierce: Would you get the amount of wetting-out of the wool fiber through the center of the microscopic fiber by wetting it in cold water that you would by holding it at 120 for three hours? I doubt it. It would only be wet on the surface, not through and through.

I had an instance two weeks ago of some goods that wouldn't dye properly. They carbonized them and dried them and put them in stock. Our whole trouble was that we ran them in the dyeing machine at 120 or 140 for about a half hour before we started dyeing. We thought they were wet but the only thing that wet them was to run them in a washer for half an hour, boiling water, then put them on the dyeing machine and boil them for another hour. Then they got wet. (Laughter.) They were not wet before. They only looked wet.

Dr. Chapin: I think you misunderstand the method of testing.

In one case the skein was soaked cold. It was dried. It later was wet for testing. In the other case the skein was soaked warm, taken out, and dried, and then wet in the same manner as the other skein for testing. In order words, the two skeins were wet again in exactly the same manner immediately before testing.

Dr. Pierce: And these weakness tests were made and weaknesses were noted in those that had been treated with acid or with the neutral solutions?

Dr. Chapin: A considerable number of tests were made, in the neighborhood of 2,400 altogether, on various skeins. Some were soaked in cold water, some in warm water, some in alkali carbonate solutions, and some in soap solutions, with and without alkali.

Dr. Pierce: That doesn't leave much hope for the wool industry because we have to boil them, and boil them hard, to get them level and get the penetration.

Mr. Masson: I don't know, after all. We have been making a lot of tests in the bulk but being dyers for the trade and being responsible for anything which may happen, we have had to be very prudent, careful, and thorough. But we have been coloring mostly black, after-chromed black. In this particular case it was Erio Chrome Black T, coloring at 170, that is, warm enough to exhaust the bath, chroming at the same temperature for half an hour, and the result obtained has been good. That means the color did not bleed. It was fast to light and fast to fulling.

So that is an example. But before going any further I thought it was wise to stop and wait because when you are processing other people's goods you must be very careful. You pay for what happens.

Mr. Harry R. Davies: May I ask what difference you noticed in the strength of the black at 170 and that that had been previously dyed at 210 or 212?

Mr. Masson: I was surprised, myself, at that and this gets down toward Dr. Chapin's results. At 160 the wool is already greatly affected, with respect to its tensile strength. But between 210, which is very bad, and 160, which is better, there is quite a good field and quite a range, and if we could go down it would be for the benefit of the wool itself.

Mr. Hobbe: Dr. Pierce, I have been connected with an organization that has been distinctly interested for a number of years in mordants and I must agree with you that chromic acid is a bad actor in conjunction with the wool fiber. We have noticed particularly in light fastness that the residual chromic acid distinctly affects the fastness to light, even in such a thing as ordinary Chrome Blue Black, which is not as fast top-chromed as when dyed on a good chrome bottom.

As a matter of fact my former employer had a dictum that the more abused the wool had been, the more it needed to be protected from the action of chromic acid. That is, shoddy is particularly affected by the oxidizing effect of chromic acid.

I notice that Mr. Masson has picked more or less on

one or two colors, rather than saying that every dyeing made at the boil has that weakening characteristic. Did you find that it was a general phenomenon or just specific in the case of those few colors?

Mr. Masson: I took that as being general. In conducting tests on white skeins you find the same thing. In a dye bath, with dyestuff, water alone or water and acid the strength of the wool is affected, even if no chrome is used, which means that an acid dyeing will have a similar effect, although not so much as an after-chrome dyeing.

Mr. Hobbe: Every dyeing that you make at the boil then shows a depreciation in strength from 80, let us say, to 30 or 40?

Mr. Masson: Yes, from 40 to 60%. There is no question that chromic acid is a bad actor.

Dr. Pierce: Is there any further discussion on this point? We are looking for light.

Mr. Putnam: Do you not find that different colors vary? Some colors cannot be chromed properly at 170 while the color that you speak of is easily chromed over and can be chromed at 170.

Mr. Masson: Absolutely. There are some dyes which are not usable at 170—the Chrome Yellows and the Blacks like T or B, Blue Black B or T, and the Browns (some Browns, not all of them) are usable. There is a selection to be made. Those trials have not been extensive enough to be used really as research data. They are only examples.

Mr. Putnam: May I ask Mr. Masson if he has made any experiments to find out how much chrome is necessary in each case and if a great deal can't be saved by the reduction of chrome, using that chrome which is actually necessary, not that chrome which it was customary to use?

Mr. Masson: That is a question in itself and if there are any wool dyers here and if they are following the instructions of the dyestuff manufacturers—they will tell you to use half as much chrome as dyestuff, but that is not certain. As an example of that I will say that seven per cent of Erio Chrome Black T will be made fast with three-quarters of a per cent or maybe one-half of a per cent of bichromate. But who has the nerve to do it? Nobody, not even myself. I use two and two and a half.

Dr. Pierce: Mr. Masson is perfectly correct in that statement.

The old Bayer type of Diamond Black F, full shade, requires exactly three-quarters of a per cent of chrome, if you give it time enough in a laboratory, but in practical work you have to use two or two and a half per cent to get through within a reasonable time. So you always have an excess over what is really required by the laboratory experiment.

Mr. Putnam: I can't prove my statement but I think that the color is hurt by the use of an excessive chrome. I think that three-quarters is better for the color and the result is better.

Dr. Pierce: It is. I had an example of that once.

We were trying to dye silk noils with a Diamond Black F. This was long before the war. We tried to chrome it. We put on smaller and smaller amounts of chrome and each time the Black changed into a dingy Brown until one day just by accident a guage pipe broke in the boiler room of this dye-house, and the fellow had just put the chrome in the kettle. All the steam was shut off and it cooled down in the bath. It was only 140 to begin with, and it was left in the kettle overnight.

The next morning when we came there we found that this Black on the silk had chromed to a beautiful Black that was fast, but it would never do it at the boiling temperature with the full amount of chrome. We got that result just by accident. So it proves that Black is deteriorated by too much chrome and thrown into the brown shade.

The point that I have been making against Mr. Masson's question is that it is not the boiling in water or the time but it is the influence of the chromic acid which causes most of his deterioration in tensile strength of wool, and I am going to offer him inside of a week or two a black that he can get away with that will not be after-chromed, that will give him the operation in one bath.

I noticed in last month's "Dyestuff Reporter" that someone has made an extended research on the influence of increasing pH values in scouring baths. Now if someone will start a research along that line it will be very enlightening.

In all the years I have been in the dye business I have never had it said to me before that an acid bath deteriorated wool. It is news to me to hear that from Mr. Masson. If that is a fact every wool dyer wants to know it. But it will take research to prove that point. That is of great importance to the industry. I am not willing to admit it.

Mr. Masson: You know, there are those testing machines on which you turn the wheel and your skein stretches until it breaks. Well, you take about ten skeins of the same length from the same bobbin and you make those samples and those tests in your own laboratory. Then you put them in the machine and turn the wheel and you will see the difference.

Here is the next subject:

The coloring of wool in bright shades such as blue, red, yellow, orange, green and purple for decoration purposes in mixes or in stripes is today of insufficient fastness. Either the fastness to sun is obtained or the fastness to fulling but both are not secured together.

As an example I will mention Alizarine Sky Blue which

is fast to light but not fast to fulling; Erio Chrome Azurole, which is not fast to light but which is fast to fulling.

I mention that Blue. We could take a green. No, we will take a purple like Anthraquinone Violet, which is an acid color, fast to light to a certain extent, and not fast to fulling at all, and in after-chromed Violet, Naphtho Chrome Violet, which is fast to fulling and not at all fast to light.

In a green, it is not so easy. We have Alizarine Green CG as an acid color, improved a little bit by after-chroming, fast to light almost and not fast to fulling.

Dr. Pierce: And your question is?

Mr. Masson: And my question is no question at all. That is just a fact and I say we don't have any dyestuffs which give, as a rule, colors that are fast to light and to fulling.

If we solve this question it will be worth while our having come to this meeting.

Dr. Pierce: There is a little bit of encouragement along this line. There is some hope here.

Mr. Masson: You understand, I said "bright" colors.

Dr. Pierce: You have noticed that in the past in the development of dyestuffs the rule has been to introduce some new group into the intermediate from which the dyestuff has been made, in that way to develop new properties in the finished dyestuff. Of late years, however, there has been a tendency in another direction and it has been possible even within the last six months to get products on the market which may be added to the finished and dyed dyestuff which will modify its properties and slightly modify its shade.

We haven't reached these fast colors that Mr. Masson wants, but we can take direct dyes or acid dyes and treat them with a substance that condenses with them directly causing a slight change in shade, modifying some of their fastness properties. We have taken ordinary cheap direct dyes and treated them so that they become fast to boiling water and to cross dyeing, suffering only a slight change in shade.

I think the day is not far distant when we will be able to give you a product so that you may after-treat an ordinary acid dye that is fast to light and obtain from it something which is fast to fulling. At the present time we have nothing to offer but I am glad to say neither have our competitors anything to offer.

That is all I can tell you at the present moment.

Mr. Masson: Maybe some of the other gentlemen can tell us something along that line.

Dr. Pierce: I might say that what Mr. Masson wants most of all (and we would be awfully glad to know about it as well as the rest of you) is the most brilliant shade of Royal Blue which will be as fast to light as the Alizarine Sky Blue and stand fulling indefinitely and still retain its brilliance. If you know of such a color we would be delighted to hear its name and so would he.

Mr. Masson: And so will every wool dyer.

Dr. Pierce: If there is no discussion on this second question I think we may declare a deadlock. There is no such dyestuff in existence as far as we know. If any of you know of such dyes we would be mighty glad to hear about them.

Mr. Masson: Gentlemen, it is very important to get something in that line and I will tell you why.

You have to color a bright blue for men's wear. I am talking about men's wear as a rule. What are you using for that purpose? The only thing you have at your disposal is Alizarine Sky Blue. The sample has been colored in that way. It will be reproduced later on in this way. What has bled in the sample will bleed in big lots. That is all right as long as all those conditions remain equal. But if the processing of the cloth in the bulk is not quite the same as it has been in the sample—if less alkali is used in the fulling, or if the process of fulling is shorter or longer—then there will be a difference in the shade, and that is what happens all the time, in the case of Blue, Bright Green, Red, or whatever you have. Nothing else is on hand and you have to use what you have.

Maybe the next question will cover that point.

Dr. Pierce: Yes, it will cover that point.

Dr. Masson: The coloring of wool with Vat dyes of the Indigoid line is quite well known. The dyeings obtained possess very good fastness to fulling but their fastness to sun is below the requirements of the trade. Anthraquinone Vat dyes as a rule are much faster to light than the Indigoids. It would be interesting to know what progress, if any, has been made in their use on wool.

Dr. Pierce: As far as the application of Indigo to wool goes, it has been accepted as the standard of fastness to light. According to the English and Swiss scales it stands first. In the German scale of fastness it is eighth or highest. Nothing is faster on wool than Vat dyed Indigo, you will admit.

Mr. Masson: Indigo?

Dr. Pierce: Yes, sir.

When it comes to the substituted Indigoes, the Brome Indigos and other substitution products, unfortunately we slip down just a notch.

I want to read you the comparative fastness of a whole line of Indigoid products:

Indigo	1
Yellow G	2—3
Orange G	2
Brown G	2
Brown 2R	2
Red 3B	1—2

Red R	2—3
Red G	2
Scarlet G	3
Pink B	1—2
Heliotrope B	2
Violet 2R	2
Violet 6R	2—3
Substituted Indigo—	
R Shade	1—2
2R Shade	1—2
Blue 2B	2

None of them is any worse than 2½ in the scale of fastness, but that depends on whether they are perfectly and properly dyed on the wool.

Mr. Masson: Maybe in some cases that 2½ is pretty bad. If you take Brome Indigo, for instance, the brighter it is, the worse it is. It is so bad really that it is not usable.

Dr. Pierce: The whole thing is in getting the Vat dye properly dyed on the wool. Mr. Masson's question was, if the Anthraquinone dyes are faster to light than the Indigoids why would it not be better to use them on wool and why wouldn't they be faster?

We can't admit that point. There are quite a number of the Indigoids which are faster than a number of the Anthraquinone derivatives or of the Carbazol derivatives. You have to select and pick the best ones. Some of them are bad. But there are bad ones in both series.

The point against the use of the Anthraquinone products on wool is the larger amount of caustic necessary to put the dyestuff in solution which acts detrimentally on the wool fiber, in spite of the use of protective colloids or material like sulphite cellulose liquor or Protectol, glue, and such things.

In order to dye a Vat on wool it seems that the best procedure that has been worked out so far is, first, to reduce your dyestuff according to the regular formula at the proper temperature, bring about a complete reduction and a perfect solution in the stock vat.

It is then necessary to get rid of the excess caustic in some way, preferably by the addition of ammonium salts which will use up the caustic soda and replace it with ammonia. At the same time you must have sufficient of the protective colloid and something of a reducing nature, like glucose, to prevent too rapid re-oxidation. If you have the protective colloid which prevents the dyestuff re-oxidizing to a crystalline form, which allows it to penetrate the fiber and oxidize to a perfectly amorphous coloring matter—and the glucose or molasses or whatever you have there prevents it from oxidizing too rapidly—then you should get a perfect dyeing. Afterwards that is developed by boiling it with a fairly strong acid solution. And that is as far as you can get with the Vat dye.

It is a question of the individual dye. It is not a general rule that the Anthraquinone product is uniformly faster than the Indigoid. It is more a question of applying the dye in the most satisfactory manner.

I am sorry to say that there hasn't been enough work done on that. It is still in its infancy. A great deal of research can be done on both the application of Indigos and the Indigoids to wool. It is a coming thing. The trade is going to demand it, and it is the only way that you will get the full, bright shades fast to light and fast to fulling. When I say "fast to light," I mean if the fastness is two that should be satisfactory for most anybody, although an ideal of one is something we would like to have, but if we can't have that we will take two.

Mr. Masson: There must be a great many wool dyers here. Is there anyone here who can tell us if he has had any experience in dyeing Vats on wool? I have been doing it for two or three years and I am about ready to drop it, it is so hard. You are never sure to get the same results. The least impurity on the wool will make the color dirty, due to the fact that part of it is not fixed, it is on the outside in a reduced form, making the color dirty. And, really, it does not pay, for the trouble you have to go to. You try to do it better and the result is that you lose your nerve in doing it and do not get the result you are after. That has been my experience. Perhaps some of you are getting better results.

Mr. Davies: While I am not a dyer I can give you an interesting observation on your experience.

A little over a year ago I was in England and happened to learn about and actually see samples, which had been produced by an internationally known firm of Scottish manufacturers, of highest grade woolen cloths both for ladies' and men's wear, and even in such light shades as camel's hair shades they decided to dye all their stock with Vat dyestuffs, for two reasons: One, that dyeing at a low temperature (this links in with your first question) they got better strength and a loftier and better feeling wool, and also they got, they claimed, better fastness. The question of fastness to light isn't so important in Scotland or England because they have very little sunlight there. But as far as all other working requirements were concerned they were perfectly well satisfied to abandon chrome colors in favor of Vat dyes, principally because of the better feel they got on a very high-class woolen merchandise which is known the world over.

Mr. Masson: That is what has made me stick to that for so long a time, the fact that it is colored at a temperature of 130 degrees.

Perhaps Dr. Meyer can give us some information on the use of Helindone colors, which are in that class. He has had quite an experience along that line.

Dr. H. Meyer: I have made a number of tests along this line and I exposed some of those shades for three months in sunlight and they didn't fade at all. In fact, I found that they got even brighter.

Take, for instance, Scarlet for the United States Army —they exposed that for three months and it didn't fade at all. It was just the same shade as before. I refer to the Scarlet used for stripes.

The same thing is true of Green, Helindone Green, It is not as bright perhaps as Cyanine Green, or as bright as you would want it, but you can expose that to three months' sunlight in the summer and it won't fade at all.

Mr. Masson: I agree with you. Jade Green—you call it Helindone Green; it may be very closely related—is the best. It is fast to fulling and to light but it is a hard color to deal with.

Dr. Meyer: On the other hand, we had some shades dyed for the Government with Helindone Blue 4B. That is a fairly bright blue, perhaps not quite as bright as you might want but you can expose that also for three months and it won't fade. Of course, I speak always of sunlight exposure. I do not refer to the Fade-Ometer exposure. That is one place where the Fade-Ometer does not show the real exposure.

Mr. Masson: We are using Helindone Blue 4B and we find it bad. We have to reach about two per cent of dye before we get a sufficient fastness to light. All the light shades are really no good at all.

Dr. Meyer: I don't have that card with me now, but I exposed even a light shade of Helindone Blue 4B and it stood up perfectly well. The same thing applies to a tan shade.

Mr. Masson: I will show you my test and you show yours. We will compare them.

Dr. Meyer: I even exposed your tests and they didn't fade. I guess it is the Fade-Ometer you use—

Mr. Masson: Those were Fade-Ometer tests.

Dr. Meyer: As I say, you cannot use the Fade-Ometer. I exposed your own blue dyeing to sunlight and it didn't fade.

Dr. Pierce: I believe I started that thing many years ago with the ultraviolet mercury vapor lamp in testing dyes for fastness to light and I found it had to be abondoned because the action was distinctly a reducing action on the dyestuff. In those days we had Indanthrene Yellow and exposed under that mercury vapor ultraviolet lamp it changed to the greenish color of the reduced dyestuff, but exposed in the sunlight the action of the sun on the moisture in the fiber produces ozone and hydrogen peroxide and you have distinctly an oxidizing action. So I do not believe in using the Fade-Ometer for testing Vat dyes. I do not think it is dependable in that case.

Mr. Claflin: I might say something in regard to the deterioration of wool by water. I think interesting tests could be made by analyzing the water in which you boil the wool. I think that wool is a more or less reactive colloid. We are too apt, I think, to consider wool as an inert substance and in the presence of water I think wool tends slightly to ionize. The ionization is increased in alkaline solution and is decreased in acid solution up to a certain degree. I think you will find more deterioration in wool boiled with plain water than you will in wool boiled in an acid solution, and I think one grave trouble in testing the strength of wool by testing the yarn is due to the increased felting effect by raising of the scales, to which Dr. Chapin referred; that when you have an actual deterioration as shown by analysis of the water you still get an apparent increased strength in the yarn because it has felted and has held together better, and of course that is increased as the twist in the yarn is increased.

So that you will get a very wide variation as you test different kinds of yarn. I think if you test the actual wool fibers you will probably get a great deal of information, although there is a great difference in the fibers themselves. In fact, they vary according to the diet of the sheep, and all that sort of thing.

But I don't recall that I have had any experience on the Vat dyestuffs. However, I think it would be interesting to see how low it is possible to carry the pH and still keep the Vat dyestuff in solution, and I think generally the tendency has been to keep the pH too high for wool dyeing. I think it can be kept in solution at a lower pH and that would be the method to be used to dye wool with a Vat color.

Dr. Pierce: There was a method introduced quite a number of years ago, I guess ten or twelve years ago, in which the Vat dye was reduced in the regular manner and then to the reduced solution they added sodium bicarbonate which neutralized the caustic and produced normal carbonate, there being present some protective colloid which prevented the precipitation of the dyestuff at the time. Then you had to go ahead and hurry through the dyeing rapidly before the precipitate formed and if you got through with it in time you got the shade you were after. But if you didn't you got a sludge. That process was originated by one of our American manufacturers. I was connected with them at the time. I think you know the concern that brought that up.

Mr. Masson: Yes, I do.

Mr. Baldwin: I should like to hear something about the Indigosols.

Dr. Pierce: There isn't anything I can say about them because we do not handle them.

Dr. Milton Harris: I might mention, with respect to

the deterioration of wool, I think it is to be expected that wool will deteriorate much more rapidly in plain water than in acid. As the gentleman just said, wool is very active. I think it is a great mistake to consider wool an inert substance. Water brings wool a considerable distance from the iso-electric point and it becomes very reactive at that point. I think the bichromate brings into effect another reaction, that is, a salt reaction.

The salt reactions are specifically different from acid or alkali reactions. We know very little about their chemistry except that some salts will go so far as to dissolve silk and wool.

Of course, then, there is the other point of oxidation but I think you will find if you boil wool at high temperature, even under low pressure, you can actually measure the chemical deterioration of the wool by increasing the hydrogen.

Dr. Chapin: I think I can hazard a guess as to where wool will be least weakened; that probably is at its iso-electric point which is supposed to be about 4.7. I imagine this point varies somewhat with different kinds of wool.

Wool in pure water with a pH of about 7 is in what amounts really to an alkaline condition in relation to the wool itself. That is, it is in a solution less acid or more alkaline than the pH of the wool. At pH 4.7 you have the pure wool substance. At a higher pH you may have a sodium salt or a potassium salt or what not of that wool substance. With a lower pH you have a wool chloride or a wool sulphate or what not. The pure wool, free from either type of salt is probably the strongest.

Mr. W. L. Sjostrom: What is it you would like to know about Indigo Blue dye?

Mr. Masson: That is a question which I am glad you are bringing up.

In the dyeing of dark shades of Indigo, at least in my case, I am liable to get the shade on the grey cast. That means it is not as bright as it should be. We do the dyeing in a steel tank. I understand it is done as a rule in a wooden tank. I would like to know if the steel has any action on the Indigo.

Mr. Sjostrom: I can give you my experience on that, Mr. Masson.

Some forty years ago at the Lowell School we dyed thousands of pounds of Indigo Blue from a light pearl to dark blue for James Phillips at the Pittsburgh Mills. We dyed that in wooden vats and we probably dyed fifty pounds at a time. The yarn was put on sticks underneath the surface of the liquor and two men, one on each side, turned the yarn under the liquor, and if we wanted a very light pearl shade we used a very dilute liquor. Accordingly, if we wanted a dark shade we had to dip it two or three times. We got very even results, and the Indigo was reduced by zinc dust and hydrosulphite and then kept in solution by lime liquor, and we got very clear colors.

Mr. Masson: And it was colored in a wooden vessel?

Mr. Sjostrom: Yes, in a wooden vessel. The vat was about ten feet long and there were little slats inside the kettle about a foot below the surface, and these sticks were run in there and held there by those grooves. The men turned the yarn under the liquor until the desired shade was secured.

Dr. Harris: I think somebody mentioned that the wool would be least weak at about an iso-electric points of pH 4.7. I can hardly agree with that. For one thing, although distilled water or pure conductivity water would have a pH of about 7, ordinary water when exposed to air has a pH of around 5.5 due to dissolved carbon dioxide. At a distance of 4.7 to 5.5 the wool would be so close to the iso-electric point that it would be very stable there. I mean, if you have anything plus or minus 1 pH you will find any protein very stable. I think the work quoted was done by a man in England. I think you will find that the iso-electric point of wool is much closer to 3.3 than it is to 4.7 which accounts for the stability of the wool there. Otherwise, wool would be very stable in boiling water, providing its iso-electric point was at pH 4.7.

Mr. Walter E. Hadley: Would a wool dyed in a wool fermentation vat be faster to light and washing than artificial Indigo dyed in a vat with hydrosulphite?

Dr. Pierce: Only on Wednesday of this week I was discussing that very point with Mr. Masson and I told him that I believed he would get those full bright redder shades of Indigo if his materials were not so near 100 per cent purity. That is, it was the very impurity of the old natural Indigo and the impurities of the bran Vat and the molasses Vat and all those things which acted as protective colloids and retarders and buffers that enabled them to get the results that you can't get today using 100 per cent pure Indigo with 100 per cent hydrosulphite, and I believe he is going to make researches along that line. Isn't that so?

Mr. Masson: Yes.

Dr. Pierce: I think that may throw some light on the subject.

Mr. Claflin: Dr. Pierce, I remember years ago when we were still dyeing Indigo in the fermentation vats that at that time we got better results in the hot vats than we did in the freshly introduced hydrosulphite vats. That is, one objection to the use of the bisulphite zinc dust vat was that it did not give an ordinary "hand," as bright colors as the hot vat, the fermentation vat.

Dr. Pierce: I will give you an example that I spoke to Mr. Masson about the other day.

I was with one of the larger American manufacturers

at the time they brought out the first Vat dyes and samples were sent to a prominent print works to have them tested. When the prints came through the Yellow G and the Blue GCD were the flattest, awfullest things you ever saw in your life. We had a report from the research laboratories that these dyes were 100 per cent pure and they were, and that is what was wrong with them. When they re-oxidized they re-oxidized to microscopic crystals.

What you need in a Vat dye is a re-oxidization to a perfectly amorphous film and the less structure it has the faster the dye will be. With your pure Indigo and your pure hydrosulphite the re-oxidization of the dye may take place in the form of very small microscopic crystals and you suffer in the depth and brilliancy of shade. But if you have enough inert and foreign matter there the re-oxidation will take place in a perfectly amorphous condition on the fiber and you will get a better brilliancy of shade.

That remains to be proven.

Chairman Cady: Gentlemen, while Mr. Francis is getting his apparatus ready we will declare a five-minute intermission.

. . . A five-minute intermission was taken at the conclusion of which Mr. Carlton S. Francis, Jr., showed moving pictures of his expedition to Venezuela. . . .

The Mechanism of Dyeing*

By **R. E. ROSE, Ph.D.**

E. I. du Pont de Nemours & Co.

A DYEBATH is a heterogeneous system of liquid and solid; the solid being the fiber in process of dyeing, the liquid, a solution of the dye with appropriate assistants, in water. Very obviously the dye is transferred from the liquid to the solid phase during the dyeing process and the process is more or less irreversible, according to the finer characteristics of the particular dye and fiber in question.

In the early days of chemistry so fast a union as that between dye and fiber was only to be explained as chemical, then with our increasing knowledge of the specific attributes of the colloidal state of matter there was a change in point of view and adsorption was advanced as explaining all the facts.

There is no question but that the colloidal adsorption theory has proved itself in the case of cotton dyeing but it is not by any means so clear that it is any more than partially true as an explanation of the dyeing of wool, silk and leather. Since last I had the pleasure of addressing you upon this subject, important additions have been made to our knowledge, so important that I believe it well worth our while to devote some time to their consideration.

We may start with wool. Our knowledge has grown regarding the actual structure of this fiber. J. B. Speakman published in the transactions of the Faraday Society the results of an extremely ingenious investigation. It was his purpose to demonstrate that the wool fiber was a complex of micellae, impervious to water and dyestuff and of intermicellar or capillary spaces. His method was based upon the well known fact that wool is much more easily stretched when wet then when dry. He started by determining exactly the energy needed to extend a wool fiber 30 per cent of its length in water. I do not know whether this had been done before, at least it had never been done with the object of using the results as Speakman did.

He found out that the energy required to stretch the fibers in water was 1.43×10^5 g/cm. per cc. and that in methanol the energy required remained nearly the same, being 1.72×10^5 g/cm. per cc. Ethyl alcohol did not soften the fiber as much, the energy required being nearly twice that needed for wet wool or 2.44×10^5 g/cm. per cc. The next higher homologue, n-propyl alcohol, was less effective but still produced an effect, the energy requirement rising to 4.43×10^5 g/cm. per cc. Going one step further to n-butyl alcohol the energy input necessary to stretch the fibre 30% rose to that necessary if the fiber was dry and in air, i.e., 5.02×10^5 g/cm. per cc. N-amyl alcohol shows no different result. In exact agreement with this are the amounts of these liquids adsorbed by dry wool.

Water	34 %
Methanol	28.7%
Ethyl alcohol	24.4%
N-propyl alcohol	3.3%
N-amyl alcohol	0.3%

* Presented at Saturday morning session.

Another point should be observed, the percentage elongation at the breaking point is

50.4 for water
40.9 for methanol
43.2 for ethyl alcohol
37.1 for n-propyl
31.3 for n-amyl
33.8 for n-butyl

From these facts the author draws the conclusion that the intermicellar spaces in wool into which other molecules can fit are of the same order of magnitude as that of the normal propyl alcohol molecule. It seems to me that it might be well to say that the largest spaces, if they differ much in size, are of these dimensions.

Before referring to Speakman's attempts to explain these facts in terms of the chemistry and mechanics of the wool fibre, I wish to quote from a later paper by the same author. Here he uses mixed liquids and finds that while octyl alcohol exerts no influence on the resistance of wool to stretching, a mixture of ethylene glycol and octyl alcohol is nearly as good a softener as the glycol alone.

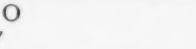
Octyl alcohol	5.17×10^5 g/cm. per cc.
Ethylene glycol	1.63×10^5 g/cm. per cc.
Octyl alcohol and ethylene glycol	1.72×10^5 g/cm. per cc.

In the mixture the molecular concentration of the glycol was only 60.8 per cent and hence it is reasonable to assume with Speakman that the glycol opened up the intermicellar spaces sufficiently to allow of the entrance of the large n-octyl alcohol molecule, itself roughly twice as large as the spaces. Here we begin to see the interest that attaches to these results as bearing on the problem of the mechanism of dyeing.

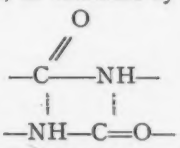
Returning to the author's earlier paper we must note that he emphasizes the remarkable effect of compounds containing the hydroxyl group, that is, the capacity to enter into the intermicellar spaces and swell the wool depends not only on the size of the entering molecule but also upon its constitution. Constitution alone is not the determining factor otherwise glycerol would be nearly as, or perhaps even more effective than, ethylene glycol whereas it is actually almost without effect. Wool is a protein, and is built up of units of amino acids, that is, molecules containing the atomic grouping NH_2—R—COOH. Emil Fischer showed us that these molecules unite together by the interaction of the NH_2 and COOH groups thus—NH_2. R. COOH + H_2N. R_1. COOH→ NH_2 R. CO-NH. R_1. COOH which in turn, since it still has the characteristic groups at each end, may unite with fresh molecules of the same or other amino acids—

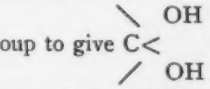
$$NH_2.\ R_2.\ COOM + H_2N.\ R.\ CO.\ NH.\ R_1.\ COOH + H_2\ N.\ R_3.\ COOH \rightarrow$$
$$AH_2.\ R_2.\ CO.\ NH.\ R.\ CO.\ NH.\ R_1.\ CO.\ NH.\ R_3.\ COOH$$

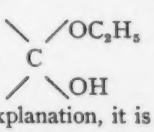
and so on until enormous molecules are built up. We used to consider such big molecules, if they were not crystalline, as no better than solid liquids without any internal structure, now thanks to Staudinger, Mark and others we are learning that such big complexes arrange themselves in a definite position with respect to each other, even if this is not so definite as in crystals and that there is a unit, the micella, which is a big overgrown molecule. In the case of wool we may assume reasonably that the micellae are chains of protein molecules and that in the fiber these are held together by residual affinities, the binding being much less firm than a chemical bond and yet no different.



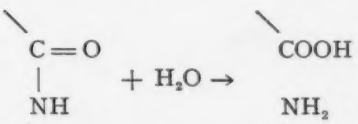
The group—C—NH—is not fully saturated and may attract a similar group as indicated in the diagram, the CO pulling the NH to it, as indicated by the dotted line.



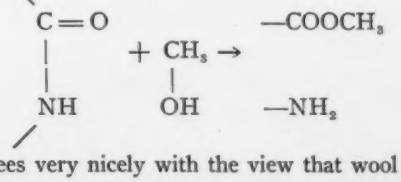
If anything overcomes this hold, the fiber will loosen up, the micellae will become ungummed as it were. If water adds itself onto the C = O group to give  this will loosen the co-ordinate linking and the micellar rigidity will be lessened.

Alcohol may do just the same thus 

However, this may not be the true explanation, it is quite possible that the water acts upon the protein to hydrolyze it; thus:



Methyl alcohol acting in this way would give



This agrees very nicely with the view that wool dyeing is brought about by a loosening up of the wool fiber structure by the mineral acid followed by an interaction of the dye acid with the amino-groups formed. In other words water alone merely opens the fiber without any real hydrolysis, mineral acids hydrolyze the protein grouping and make available amino groups, these take up the dye

acid molecules which can penetrate the fiber because the co-ordinating valencies are loosened by the solvent.

The water acts like the little mechanism of the zipper fastening when it is used to open a bag, the dye molecule gets into the bag and then it unites chemically with the lining.

There is other evidence in favor of this view. You will remember that the successful use of ammonium salts in wool dyeing was once explained as being due to the loss of ammonia on heating and the slow concentration of acid. Fort refuted this assumption when he showed that a solution of an ammonium salt of the concentration used did not lose ammonia. However, in the presence of wool, the ammonium salt is decomposed rapidly though the solution may never become acid, may indeed remain feebly alkaline. The acid is robbed by the wool fiber and the dyeing proceeds not because the dyebath becomes acid, but because the necessary wool-acid reaction takes place.

You will remember the objection raised to the chemical explanation of wool dyeing that it was unreasonable to expect the basic amino groups of wool to hold dye-acid molecules when there were enormous quantities of much "stronger" mineral acid molecules present. That objection belongs to the days when we thought in terms of complete reactions and of acids as expelling each other completely in the order of their strength. Now we know that we must assume an equilibrium, if the organic acid is as highly dissociated as the naphthalene sulfonic acids of dyes, and that the equilibrium point will be influenced largely by the relative solubilities of the components.

K. H. Meyers has been able to show that only a 13th part of the total nitrogen present in wool has the power of neutralizing and holding acids, that the combining equivalent of wool is therefore much greater than we used to assume. Actually 1200 g. of wool are an equivalent, on which basis it would be theoretically possible to produce a 29 per cent dyeing of Orange II, actually even for a black a six or 8 per cent dyeing is the maximum. The equilibrium state reached at the end of an acid dyeing is then very far from being a complete ousting of mineral acid by dye acid. There is nothing remarkable in the persistence of the dyestuff-acid-wool complex.

In giving you a resume of Speakman's work I have referred to the wool fiber in terms of a micella structure because the author does so. I wish to go into the matter of the characteristics of fiber substances later when I come to the subject of cotton, but even here I should like to point out that the term micella in connection with fibers does not describe particles similar to those present in soap solutions, which are also called micellae but are agglomerates built up in quite a different way. Staudinger sees no reason for assuming that the units going to form a fiber are anything other than numerous molecules. These form, by parallel association, the smallest fiber unit and this is what he would term a micella, if he used the term at all. On the other hand H. Mark would seem to use the term micella for a smaller portion of the big molecule, having crystallite properties. The difference is important enough to require emphasis.

It is well known that Cellophane makes an excellent semi-permeable membrane. It can be used in boiling solution if necessary. Taking advantage of this fact I have carried out a series of experiments to check the findings of others regarding the particle size of dyes, more especially under the conditions obtaining in the dyebath. The usual method of testing has been to determine the rate of diffusion in a gelatin jelly, a method suffering from one very obvious limitation; it can not be employed at the temperature at which dyeing is carried on. Since temperature may influence the degree of dispersion of a colloid and its hydration, just as it can the hydration of the ion of a salt, it seems to me that my method possesses distinct superiority, even though I have not yet been able to refine it to a point that will allow of measuring differences in the degree of dispersion as precisely as can be done by the gelatin method.

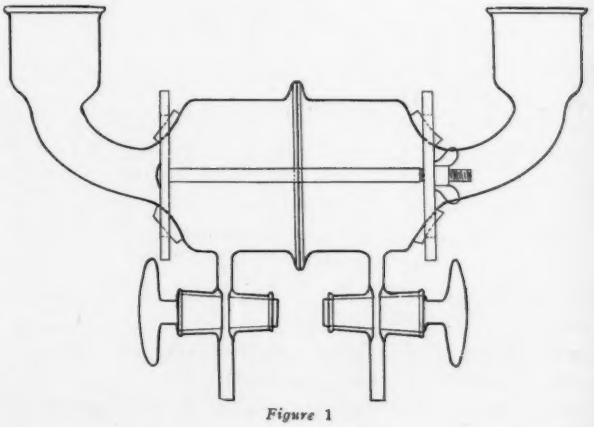


Figure 1

The little instrument I have used is very simple. It is a glass cylinder divided into two parts centrally across the long axis. Each half is fitted with a narrow flange and the surfaces of the two are ground together to give a water tight fit. A Cellophane diaphragm can easily be placed between the ground glass surfaces and held there by clamps running the whole length of the cylinder. Each end of the apparatus terminates into a tubular turned upward and widened so that the level can alter or be kept constant as desired. The Cellophane used for my experiments was not especially treated but was the regular No. 300 material. This contains some glycerin as a softener. The solution of dye with the prepared assistants was placed in one side of the cell and a solution of the assistants alone, of equal strength, on the other. When it was expected that the dye would diffuse readily the experi-

ment was conducted at room temperature, if dispersion was not apparent after some hours, or if it was not expected, the whole cell was lowered into a constant temperature water bath and heated to the lowest dyeing temperature used in practice for the color upon which the experiment was being made. If under these conditions diffusion was not apparent, then the temperature was raised up to that of the maximum used in dyeing, some times a little higher. I hope to give a precise account of my experiments in another paper, but here, where I am treating of the general subject of dyeing, I will do no more than outline the results I have obtained.

I did not expect, when I started out, to find that my method would enable me to add anything to what was already known. Rather I thought I should merely confirm reports already made by others and known to me by my own previous observations. In general, I expected to find that all basic and acid colors, since they are described as forming molecular dispersions, would pass through the membrane. Direct, sulfur and vat colors I assumed would be too coarsely colloidal to pass through.

As usual when one appeals to facts, I obtained some very curious and wholly unexpected results. It happens that No. 300 Cellophane is so constructed as to be almost pervious to most dye particles in the condition they assume during dyeing. On account of this the membrane does not merely distinguish between colloid and true solution, it distinguishes between colloidal particles of different sizes as well. At present I am speaking of wool, and I shall mention only those of my results that refer to wool dyes.

According to the literature wool dyes, without exception, form true solutions, and my first experiments confirmed this fact fully. Tartrazine, Pontacyl Carmine 2G and Alizarine Saphirole B are all typical acid colors and they all diffuse through the membrane even at room temperature just as do the basic colors. However, when a considerable number of acid colors is compared, even though all diffuse, a certain difference is evident in the ease which they pass through the membrane. I made no attempt to measure these differences, but I hope to do so later, as I believe that to study them will give us more insight than we now have about the behavior of wool dyes. When I tested some neutral dyeing and some very acid sensitive colors such as the Sulphon Cyanines, I found to my surprise that all of these refused to pass through the membrane, or, at the most, only to a very slight extent at a temperature near the boil. In the case of the Sulphon blues some colored material did pass through, but it was not blue, and was apparently a reddish impurity in the dyestuff. This discovery collerates particle size and dyeing properties in the acid color series, which so far as I know has not been done before.

In order to correlate what I have just said with the behavior of typical cotton colors, although I shall have to return to that subject later, I may say that most direct dyeing colors are too colloidal to pass through the membrane. But (and this is also a surprise to me) I may tell you that this is far from being true of all of them, especially at higher temperatures.

My experiments show that we may have acid wool colors that are colloidal, and that these are types that behave characteristically in being driven on very easily by acid or in dyeing from a neutral bath. At present I can only see an explanation for my results if we assume that the degree of dispersion varies between very much wider ranges than we have been accustomed to assume. Also it seems to me that it indicates that wool dyeing may take place in more than one way. About all of this I hope to say more when my experiments reach greater maturity than at present.

Silk

The mechanism of dyeing the silk fiber, which is very nearly related to wool, must be similar except that when the silk fiber is opened up by acid it exposes a surface that is much more acid than in the case of wool. This probably explains why it is that basic colors go on to silk so much more easily than on to wool. I do not think that we need say more about this fiber except perhaps to mention that in tin-weighted silk we have a condition that rather upsets the ordinary equilibrium between dyebath and fiber. Apparently the tin-weighting enters into the swollen fiber very much as a dyestuff would and when it is precipitated there it blocks the fiber for dye particles. However, it does not amount to a complete resist, and if we select suitable colors, we can still get good dyeings. However, the exhaust is usually extremely poor and the time of dyeing has to be prolonged over that necessary for dyeing pure silk. I think we can do a good deal of interesting work on comparing these two types of fiber, because there are indications that factors other than mere chemical constitution play a very considerable part here.

Cotton

The structure of the cotton fiber has received more attention than that of the wool fiber. When we found out how to analyze organic compounds we learned that cotton was composed of carbon, hydrogen and oxygen in the same ratio as those elements occur in glucose less one molecular formula of water. In other words that cotton was composed of a poly-saccharide, cellulose, having an empirical formula $(C_6H_{10}O_5)_n$. When we learned more about carbohydrates we found that cotton was essentially pure cellulose and that it could be converted entirely into glucose. Very recently we have gone further and discovered that the typical unit structure is what we call beta-glucose. The beta-glucose molecule is a body forming roughly a flat ring and the groups in the ring are best shown diagrammatically as you see in the sketch on

the screen. There has been a great deal of discussion regarding the nature of the group built up of these units. Formerly we assumed that all organic molecules were held together by covalence. However, when we discovered that there were organic bodies linked together by secondary valencies, then it seemed possible that the big unit of cellulose was an aggregate of little units held together not as a molecule but as a micella. This is a variation of the old idea first advanced by Nageli that in cellulose there were crystalites which were in a sense unit bodies. H. Mark was particularly influential in advancing this view of the nature of cellulose. His argument was

Figure 2

based on the facts that cellulose shows a crystalite structure when examined by X-ray diffraction. On the other hand Staudinger has interpreted the same facts and others determined by his experiments as meaning that cellulose is no more a linking of separate entities than any other organic molecule. According to him this very important substance is a highly polymerized molecule. He bases his contention on studies of simpler molecules, such as the poly-oxy-methylenes. Since it appears as though Mark were coming to the view of Staudinger, and since Staudinger's views appeal more to me as an organic chemist, I thing that I will place more emphasis on them here than on those which differ from his. Staudinger's view of cellulose is that it is a system of macro molecules. A macro molecule is a relatively immense organic molecule built up by the union of elements through their covalencies. In the case of cellulose the unit molecules are at least 1200 times the ($C_6H_{10}O_5$) basic unit. This would give a molecular weight of around 190,000. Such macro molecules, if given a chance tend to associate in parallel bundles but they do not form bundles in which the ends of the molecules are all on the same plane. These irregular groupings form crystalites, and cellulose is nothing but a large mass built up in this way. The relative dimensions are roughly that the cellulose molecule has a length one thousand times its breadth. Its actual length is of the order of five thousand Angstrom units. The breadth must be somewhere between five and ten units. An Angstrom unit I may remind you is one ten-millionth of a millimeter, so that the unit of cotton is a minute thread, a thousand times as long as it is wide, and of a length such that there would be 500,000, end to end, in one inch of cotton fiber. As a matter of fact we must not think of these molecules as lying end to end, but, as I have said, as overlapping. In all of this it is necessary to remember that when we deal with macro molecules we can not disassociate them from the film of solvent, usually water, which is dispersed on their surfaces. Perhaps it would be well to remind ourselves of this by using the term micella for the whole system of the solvated macro molecule with its field of electric force. All our explanation of the dyeing of cotton must be in harmony with this structure.

It is characteristic of cellulose, as it is of macro molecular organic substances in general, that the macro molecules are extremely unstable, except when supported by each other. If we cause cellulose to swell up, for instance, by treating it with caustic in mercerizing it, we do not have at the end of our treatment cellulose molecules of the same length as those with which we started. Such a treatment opens up the spaces between the threads of the cotton, (here I am using thread in the sense of the molecular unit) without separating them where they overlap. In this way a sort of bulging net work is formed. Some of the molecules are ruptured and others retain their original length. If we exert a pull on the net work the bundles try, as far as possible, to become parallel again: but the original covalencies are not re-established and there is a tendency to the thickening of the cross section of the whole system, not of the individual molecules. That is what we get by mercerizing.

When we use a direct dyestuff the molecules of the dye pass into the spaces between the cellulose molecules because these have been opened up by the action of the solvent together with the assistants we have used. Once within the cotton fiber the dye particles are attached to it by unsatisfied chemical attractions and this is perhaps promoted by the electric condition of the colloidal dye particles. Once the dyestuff is attached to the surface of the cellulose it forms more or less of a new chemical unit and this is the actual dyed material.

There is one fact that appears from this view of dyeing

and that is that the surface available for the dyestuff molecules is relatively enormous. Thus, we can see if we carry out a very simple arithmetical calculation of the growth of surface with the increase in number of particles. For instance, let us take a cube of square centimeter face, the total surface is six square centimeters. If we cut this tube into little cubes of one square millimeter face we have 10^3 cubes with the surface of 60 square centimeters. For cubes of 1/10 millimeter we have 10^6 in our original cubic centimeter, and the surface area becomes 600 square centimeters. Now suppose that the process is carried on until the original centimeter is divided into cubes just vilible under the microscope, that is, of 1/10,000 of a millimeter. Then the surface becomes no less than 60 square meters, or roughly the same number of yards. The macro molecules of cellulose are not visible under the microscope. They are long enough but not wide enough to be seen. It is not unreasonable to assume that for one gram they present as much surface as would cubes of 1/10,000 millimeter. This would mean roughly that for a 5 lb. dyeing of a direct color five hundredth grams of dye has a surface equal to that of five 9 x 12 rugs on which to be adsorbed. Even assuming that the proper balance of forces is found only here and there on the surface, there is no difficulty in accounting for the result.

What we have said does not explain why a dye is substantive, it is merely a mechanical conception of the dyeing processes based on what we know of the structure of cellulose. If we investigate the character of the dye we find that its particle size seems to be one of the most important attributes in determining whether it will be substantive or not, but in addition it seems certain that the shape of the dye molecule is significant, as well as the basic chemical constitution as determining the play of forces on the surface of its molecules.

I have already told you of the results I have obtained in investigating the acid colors by means of a Cellophane membrane. I have done the same with a considerable number of cotton dyes and the results I get differentiate these dyes into groups which do not quite coincide with the classification previously current in the literature. I find that there are direct colors that will diffuse quite readily through the membrane. For instance, Chrysophenine is typical of this class and the same is true in general of all direct dyes that are very level dyeing on rayon. Remember that I am speaking of a solution heated to the temperature of dyeing. The direct blacks and direct blues are without exception incapable of passing through the membrane. I am not certain of what I am measuring in these experiments. Those who know most about Cellophane tell me that it is a membrane with no holes in it and if that is so, I do not see why some colors go through and some do not. In fact, I find it difficult to account for the passage of the color from the one side to the other through what might just as well be a pane of glass, if it has no pores in it. It may be that while the Cellophane shows no pores in the ordinary sense, it is so constructed as to be a net work of cellulose molecules and that the dyestuff passes through the spaces between the molecules which may be of the order of 7 to 10 Angstrom units. I feel that we have a great deal to do before we understand the cause fully, but at the same time the results are certainly very interesting. I have just said that it is possible to pick out the level dyeing colors for rayon by the way they pass through the membrane. This seems to mean that the degree of dispersion is of the first importance in level dyeing—a conclusion that is contrary to that reached by W. Wettzein and K. Schulze, who insist that the rate of dyeing and the effect of inorganic salts in driving on the color are more significant; that is, that dyes that go on with little salt are also the most level dyeing.

However, colloidal dispersion in itself does not make a dye substantive. Ruggli has gone to a great deal of effort to prove this point. He has built up a molecule that eliminates all variables except that of increasing size. He did this by coupling amino-benzoyl J acid with itself repeatedly. In this way he obtained large colloidal dyestuff molecules but at no stage in the series did he obtain a substantive color. It should also be remembered that a mere increase in molecular weight does not necessarily mean an increase in the size of colloidal particles. For instance, if we take a vat color which does not pass through the Cellophane membrane and convert it into the corresponding indigosol dye, which has a slightly greater molecular weight, the latter will go through the membrane very easily.

Again it has been suggested, and there seems very good reason for the assumption, that the shape of the molecule is important. This assumption is supported by the fact that those molecules containing a long flat benzidin nucleus or a stilbene grouping are substantive.

When I examined the other cotton colors by means of the Cellophane diaphragm, I obtained results that I think you will agree are interesting. The sulphur colors as a group refused to pass through the membrane under any conditions. And this confirms the statement of other investigators that they are the most colloidal of all cotton colors. The Anthraquinone vat colors fall into two classes. The cold dyeing colors go through the membrane under the conditions of the dyebath and they do this, as a rule, more readily than the warm dyeing group, but the two groups do, in certain ways, overlap. For instance, Pensol Brown AR diffuses less readily than Ponsol Yellow G. The blues of the vat color series do not go through the membrane at all. Ponsol Violet RRD does so. The thioindigoid colors all go through the membrane as far as I have tested them and the same is true of all their sulphonic acid derivatives, the indigosols.

Indigo itself runs through the Cellophane membrane as fast as an acid color, confirming the dyer's knowledge that this ancient and venerable dye has practically no affinity for cotton and resembles an acid color when it is in a form of indigo white.

Discussion

President Wood: Would anybody like to discuss any of the points Dr. Rose has touched upon in his paper?

Mr. Hobbe: I would like to ask Dr. Rose what Cellophane is. I assume it is a straight cellulose nitrate. Is it?

Dr. Rose: No, it is a straight regenerated cellulose. It corresponds to a sheet of rayon.

Mr. Hobbe: Viscose?

Dr. Rose: Viscose.

Dr. Powers: I was wondering if in Dr. Rose's comments, after all, he wasn't really determining those colors which will dye rayon and those which will not dye rayon, assuming that any color that will dye rayon will apparently diffuse through his membrane and any color that will not dye rayon will not diffuse through his membrane. Dr. Rose, aren't you really dyeing your sheet of rayon on one side? Then that in dyeing through, the film is slowly washed off or bled off on the other side. So that after all your membrane is merely a measure of cotton colors as against non-cotton colors and may or may not give you a measure of particle size. Isn't that so?

Dr. Rose: If Dr. Powers is correct, then I have a real measure of what I tried to get at because the dye particle must be going through the spaces between the micella, if you like to call them that, of the cotton, or, in this case, of the rayon.

Dr. Powers: Isn't that a function of the substantivity, if you want to put it that way? In other words, a color that has no affinity for cotton will not migrate even though the particles are minute.

Dr. Rose: I don't think so because all the acid colors go through so very readily.

Dr. Powers: Those same acid colors under the same conditions—won't they stain rayon?

Dr. Rose: No, they go right through and they go right on.

President Wood: Are there any other questions?

Mr. John D. Hunter: I would like to ask if you found any relationship between the dyes which will penetrate the Cellophane and the fastness to washing of the dyes as a group.

Dr. Rose: If you are talking of substantive colors, the ones that go through the Cellophane are not fast.

For instance, suppose you take a mixture of Sky Blue and Chrysophenine and put it on one side. Sky Blue won't go through at all but the Chrysophenine will go through. The membrane when you take it out is a vivid yellow with spots on the one side of blue. There is a certain amount of dyeing but it doesn't get through.

If you take that membrane and soak it for a little while the yellow will bleach out altogether but the blue will stay.

So that it would look as though anything that went through under the conditions described could also be washed out.

Dr. Wm. D. Appel: Mr. Chairman, I would like to ask Dr. Rose, in the case of the hydrogen and gases diffusing through if he hasn't an anomaly to explain, because the small molecule or atom doesn't go through. Have you any knowledge in connection with a large molecule or a large particle going through when a smaller one will not? That is, measuring the particle size by some other method.

Dr. Rose: Dr. Appel, there is an interesting point in that connection. I don't know how well it answers your question. But suppose you take a vat color of a particle size that will hardly allow it to get through the membrane. Let's say you have to raise the temperature and even then only a little color oozes through. If you turn that into the corresponding leuco compound and then from that into its sulphonic acid derivative, turn it into an Indigosol, it will go through almost as fast as Indigo White. It will act as an acid color.

Either you have to assume that the aggregate of the colloid is broken up or you have to assume that the molecular size doesn't make much difference, and I don't know which it is yet.

Mr. Hobbe: May I ask Dr. Rose whether the membrane swells markedly on wetting? That is, is it the same as when you try to pass gas through it in the dry state? When your liquids come in contact with it does it markedly swell and form a different membrane?

Dr. Rose: The Cellophane when you use it is quite moist. You see, to keep it from cracking and keep it moist it is treated with glycerine anyway. It has about six per cent of glycerine and a certain amount of water so that the gas is absorbed, and I haven't measured it but I don't think it swells very much. It swells if you put caustic in it but it doesn't swell much if you treat it in the ordinary dye bath. The Cellophane people themselves say that perfectly dry Cellophane is so rare a thing that they have never had a piece and that they assume if they got it quite dry, gases would go through much more readily than they do when it is wet, which confuses the issue still more, doesn't it? (Laughter.)

Dr. Powers: In regard to the question of Cellophane it would seem possible to reason on the same ground as if it were a sheet of rayon, a perfectly smooth sheet of transparent rayon, and of course, rayon has a normal moisture content of approximately 11 per cent. Rayon, when put in water, will take up about 85 per cent of its weight in water. Wouldn't it be reasonable to assume that Cellophane under similar conditions takes up about the same amount of water as rayon?

Dr. Rose: Yes, I think that is a very good point. I expect it does, as a matter of fact. We haven't paid much

attention to it but it probably does absorb a great amount of water.

President Wood: Are there any further questions? If not,

Mr. Quade: You made a statement about the different force which it took to stretch the wool thread in different solvents. Do I understand that you imply that we might modify and temper the kind of dyeing which we would get if we explored different solvents or different assisting agents? Of course, we do that, but I didn't understand whether you meant to imply that a lot could be done for dyeing by going into that field.

I have been particularly interested in ombre dyeing where I understand the solvent for the dye is an alkali and the question was asked: "What we might expect in ombre dyeing compared with other kinds of dyeing with respect to getting uniform results?"

Dr. Rose: Well, for all practical purposes, unless there is some particular kind of dyeing the function of the water is so much more important than anything you add to it that you get the swelling anyhow, I think, so that the mere addition of materials to the water might hasten the process slightly but wouldn't be important otherwise. If you can afford to use a bath that is entirely an organic solvent then I think there is quite a little field for work.

I may say in connection with these dyeings that I did in Ethylene Glycol you have the same characteristics as you have in water. For instance, you don't get any dyeing until you have added an acid. Then you do get a dyeing of the wool.

I should think that mixtures might be very well worth investigating because Speakman was able to show that if you had a mixture of a particle that opened up then a larger particle would go in, and something of that sort might be of considerable advantage over the present method.

Fundamental Textile Research and The Microscope*

By **PROFESSOR E. R. SCHWARZ**
Textile Laboratory, Mass. Institute of Technology

ANY worker who has ever had to deal with fiber identification with a wide range of materials, or who has been called upon to investigate fiber charactertistics whether physical or chemical, cannot long remain unaware of the importance of the microscope and its accessory equipment in connection with fundamental textile research. Not only is this true of the modern textile technologist but it was also the case with the older students of textile fibers. O'Neill studied the structure of the cotton fiber as shown under the microscope as early as 1865 with great success. Only two years ago Saskostschikoff repeated the fundamentals of this investigation on best fibers, using the same re-agents, but vastly improved optical apparatus.

During the last two or three years all the manufacturers of microscopic equipment have paid attention to designing and building instruments suited particularly to textile work. These range all the way from a simple magnifier, through finely ruled glass plates for the counting of yarns or stitches per inch in fabrics, to the ultramicroscope.

It would be out of place to attempt to discuss in any detail the complete list of such pieces of apparatus. Suffice it to say that both Bausch and Lomb Optical Company and the Spencer Lens Company have issued special catalogs devoted entirely and particularly to the listing of equipment for textile research. Messrs. Leitz and Zeiss both issue special pamphlets on instruments designed primarily for textile work. To show on the screen a complete list of pictures to illustrate these developments would occupy more time than can be devoted to the entire afternoon session. I can, therefore, show you only a few. These have been selected to illustrate the most recent and most interesting examples. Since most of the instruments bear the trade-mark symbol of the manufacturer, it would be beside the point to attempt to disguise their origin. The speaker, then, in mentioning the manufacturer, does so for the sake of completeness, and with no prejudice for or against any concern. Because of his position on the faculty of the Massachusetts Institute of Technology every effort has been made to remain neutral and to retain the respect and good will of all the manufacturers. This, we believe, has been successfully done. The co-operation of all parties concerned has been whole-hearted, and progress has therefore been more rapid than had been anticipated.

* Presented at Saturday afternoon session.

Textile Microscopes by Bausch & Lomb.

The study of textiles would be either a joke or intensely tragic, depending upon the point of view of the observer, if the investigation of cross sections of fabric, yarn, and fiber were not included. Any follower of the literature on textile microscopy cannot fail to have been impressed with the importance of this field. The design and construction of a microtome which should be eminently suited to the handling of textile specimens and which should be obtainable at a reasonable cost has been of great interest. It is now an accomplished fact. One instrument which embodies the desirable features and which is representative of the modern trend is shown here. Note the accessibility and visibility of all the working parts. The range is from 2 micron to 40 micron sections by steps of 2 microns. A safety razor blade holder is provided and the specimen holders and clamping device is exceptionally well designed and convenient. With an instrument of high precision, beautiful construction and moderate price available, no textile laboratory with any pretension to completeness of equipment can afford to be without one.

Interference phenomena are playing an increasing part in textile analysis. The application of an optical device made of closely ruled glass, much like a coarse grating, but of progressively finer spacing, makes detection of irregularities simple. The device can be used on fiber, yarn and fabric.

The stereoscopic binocular microscope provides a most convenient means for dissecting textiles and does not reverse either the specimen or the direction of motion of the dissecting instruments as do so many of the other devices for this purpose.

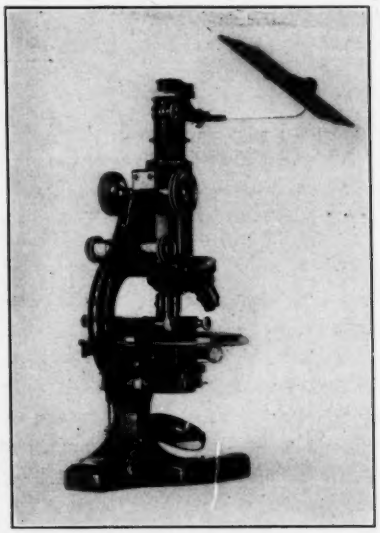
For comparison at low medium and high power a double microscope is offered and makes possible the study of two specimens simultaneously at as high a magnification as may be desired.

The textile microscope should be provided with a good camera lucida and stage micrometer for measurements and purposes of record. Several types, essentially similar in detail are available.

Modern microscope designers have departed quite radically from the older type of stand in their recent work as the instrument before you will show.

Accessory devices are also being provided for textile microscopical work, and the yarn carrier designed by Alfred Suter provides a convenient means for both the examination of yarn, and the measurement of twist.

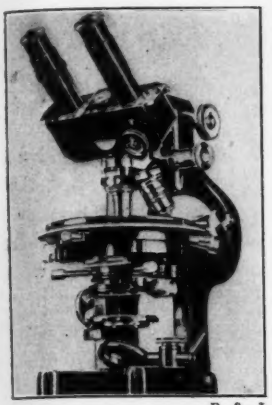
Occasionally a good thing is discovered, used, forgotten, and then re-discovered and found to be of just as much value as ever. Such an instance is that of the Rheinberg method of differential illumination. It is based upon the familiar type of lighting for the microscope known as dark field, or dark ground. This is widely used for the study of fine particles in suspension in fluids, and for the better resolution of surface detail on fibers. The specimens appear as if self-illuminated. In spite of the fact that the background is black, the fibers are lighted by transmitted light below the stage. A special condenser or substage diaphragm may be used to produce the effect. The newer condensers are supplied with a special element interchangeable with the top lens to give the dark ground effect. The Rheinberg method uses the same control of the light by means of a substage diaphragm. Instead of opaque material in its construction, however, the makers have employed glass disks and Wratten filters, so that the fibers may be made any desired color against various colored backgrounds. This is of value for photography for record. Stains very frequently either swell or shrink the specimen and thus render micrometric observations useless. By the use of the Rheinberg method the effects of staining can be obtained without fear of distortion. An additional advantage is the fact that the same specimen may be used with any or all of the possible combinations. Obviously a number of different stains cannot be used on the same sample. Still another modification allows a flax fiber, for example, to be colored light blue, while the transverse



Textile Microscope by Spencer.

markings are shown a brilliant red. No stain or combination of stains will do this as well. Further applications of direct color photography will be illustrated during this paper.

All textile specimens—even fibers—are three dimensional and, for many purposes, must be studied stereoscopically. The textile microscopy laboratory at M. I. T. has been engaged in developing techniques for the rapid and satisfactory recording and reproducing of stereograms. These techniques replace the use of a special camera by simpler accessories—so that any microscope and any camera may be employed. One device—a tilting stage—was designed by the speaker and has proven very satisfactory. Low power pictures showing yarn and fabric structure—as for novelty yarns, laces, lenos, etc., where the third dimension is of vital consequence, can be easily and quickly prepared. Careful inspection shows that the views of each pair are not identical. Since their arrangement is such as to produce a stereoscopic effect when viewed through a stereoscope, they are easily studied. Even such things as fungus, and fibers almost too small to detect with the naked eye are shown clearly in their perspective and orientation in three dimensions.



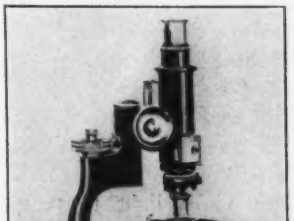
B & L

One of the newest research Microscopes.

More and more interest is being shown in the study of the action of chemicals on textiles. This is being studied through the microscope as well as in the test tube. A complete study of this sort calls for a record of the observations, which may be either very slow or extremely rapid. Cine-photomicrographic apparatus is now available for work in this field. The operator can follow the work through an observation ocular while the pictures are being taken. Thus progressive changes of focus, as well as shifts of field, may be made as needed without interruption of the photography. For the past several years the biology department of M. I. T. have been engaged in the preparation of a series of motion pictures to be used in health education work. Dr. Turner has been in direct charge of the work in co-operation with the Eastman Kodak Company, and with the aid of Professor Hardy of the Physics Department Optical Laboratories has designed and arranged a system upon which the textile laboratory with their kind permission, hope to base the construction of an outfit for textile photomicrography on motion picture film.

The microscope with one or two accessories offers a very simple and satisfactory method for determination of fiber density. This involves the measurement of the weight of a measured length of fiber which calls for the use of the microscope—usually the stereoscopic instrument—and a sensitive balance. The microscope provided with a camera lucida or arranged for projection, enables the investigator to draw in the outlines of the fiber cross sections. The area may be determined by cutting out and weighing these, or by use of a planimeter. Direct computation gives the density in gms./c. c. No difficult manipulation is involved, and no immersion fluids are required.

Another item which is of considerable importance to the manufacturer as well as the textile technologists and which will aid greatly in determination of that elusive quantity known as "spinning quality" is the *disk coefficient*. It has been shown quite conclusively by Dr. S. G. Barker of the British Textile Institute, that wool fiber of circular cross section spins to better yarn than does that of elliptical or irregular section. The effects of section shape on the lustre, transparency, and covering power of rayon, as well as on the properties of dye absorption are well known. The coefficient may be defined either as the ratio of the area of the section to the area of a circle circumscribed about it, or as the ratio of the area of the section to the area of a circle of equal circumference. The microscope, of course, serves as a means of measurement of the area of the section which has been prepared on such a microtome as was illustrated earlier in this paper. It is also the means for measuring the desired circumference. The disk co-efficient, as computed by the former method, is inversely proportional to the ratio of the average long to the average short diameters of the section.



B & L

Polarizing Microscope for advanced textile research.

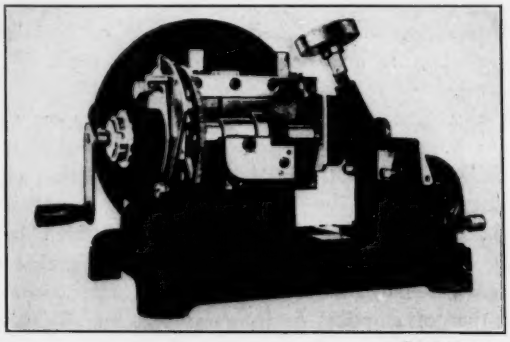
Leitz

High Power Comparison Microscope.

Yarn structure is something which has never been adequately investigated with the microscope. The speaker

has worked out a method of micro-analysis of twist which has opened the way for a more complete investigation of such yarn characteristics as ply, balance, corkscrew, etc. Certain of this material will be published shortly.

All the investigations mentioned so far can be undertaken in ordinary light. Textile Microscopy is not confined to work with ordinary means of illumination however. The use of ultra violet light to show smaller

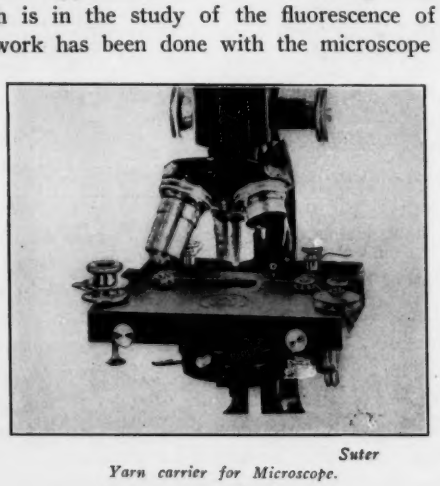


Spencer

Microtome well suited for textile work.

details of structure is possible and has been employed in Germany by Alois Herzog with some success. He divides the fibers studied into three classes: First, those which show only a faintly visible mesh-structure; second, those which exhibit well defined mesh structures; and, third, those which show parallel markings. In the first group is gelatin rayon; in the second, cotton and the other rayons; and in the third, silk, flax, and hemp.

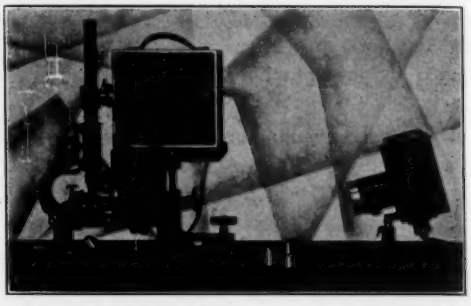
Another application of ultra violet light to textile research is in the study of the fluorescence of fibers. Little work has been done with the microscope in this



Suter

Yarn carrier for Microscope.

connection, and the results of such investigations will probably be only of academic interest, since identifications, etc., can be more simply and inexpensively conducted by other optical means. Mildew may sometimes

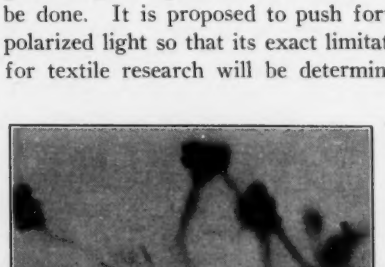


Equipment for Motion Picture Photography through the Microscope.

be made apparent on a yarn or fabric, which could not otherwise have been detected. It is stated further, that the cellulose fibers fluoresce to give yellow colorations, while the protein (animal) fibers produce bluish or violet shades. For the sake of complete information, work along this line should eventually be undertaken, but there are more pressing needs which should have preference.

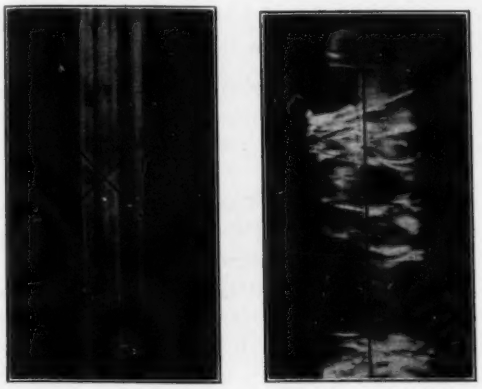
A series of investigations which promise much of interest from both practical and academic standpoints is to be found in the use of polarized light for illuminating the microscope. That this type of lighting should be employed is based on sound common sense. All textile fibers are doubly refractive—that is, they are themselves polarizers of light, and for this reason, if for no other, they can be studied advantageously by polarized light.

The textile microscope has therefore been designed so that polarizing equipment can be employed in conjunction with it without the necessity for expensive or difficult changes. The chemical microscope employs polarized light, but not in so convenient a form as either the textile microscope or the petrographic instrument. The textile stand is provided with a 45° slot for accessories such as the quartz wedge, selenite plate, etc., and thus allows a good range of quantitative work as well as qualitative to be done. It is proposed to push forward the work with polarized light so that its exact limitations and advantages for textile research will be determined.



Fungus growth on rayon.

An important physical property of textile fibers is the index of refraction. Upon it depends the luster, the optical characteristics, and such other factors as density, strength, elasticity are intimately connected with it. Its usefulness as a means of differentiation



Nitrate rayon. *Ramie*

Textile fibers in polarized light.

have not been exhausted, and its determination with precision is of considerable value to the textile technologist; and may be of importance to the manufacturer as well. Since the fibers are doubly refractive, there will be at least two different indexes depending upon the orientation of the fiber relative to the light, and type of light. One index is constant and the other is variable, reaching certain limits of maximum and minimum values for a given fiber. These indexes can only be measured in polarized light. The speaker is about to inaugurate a series of tests to establish a practical technique for use by the textile technologist for this work, and we expect that the results will be of decided interest.

For certain delicate investigations of the physical properties of fibers, it is necessary to have a good idea of the cross sectional shape and variation of shape from point to point along a fiber, without damaging or altering the fiber prior to the actual test. Examination of longitudinal mounts in polarized light allows the bands of interference colors produced to be plotted so as to outline the contour of the fiber at any point. Thus what we may term optical sections can be prepared without cutting or injuring the fiber in any way. Studies of surface irregularities, etc., can also be advantageously made by this means. The orientation of structure which, since the advent of X-ray analysis of textiles, has come to be known as "fibering," results in the density of the fiber being different in different directions, and even in certain localized portions. The so-called slip-plane effect is probably a case in point and the appearance of such fibers as flax and ramie in the orthagonal position under crossed nicols bears out this hypothesis. Doubly refracting substances are either optically positive or negative, and this characteristic must be determined in polarized light. For example, it has been shown that nitrate rayon which has not been sufficiently denitrated is optically negative, while when a degree of nitration of 11 per cent or less is reached, the rayon becomes optically positive. General problems of fiber structure can also be attacked. The complexity of cotton fiber structure is well shown by the fact that these fibers are bright in all orientations between crossed nicols, and are extinguished only at restricted portions as they are rotated. Incompletely developed fibers show characteristic uniform blue coloration after the insertion of a first order selenite, and this color changes to the complementary yellow upon rotation of the fiber through ninety degrees. These fibers extinguish in the parallel position under crossed nicols alone. It has also been claimed that certain rayons show a sort of case-hardening when examined in cross section under crossed nicols. There seems to be a border of appreciable width which gives a different interference color from the body of the section. Since the sections are microtome cut and of uniform thickness, this must be due to change of index as a result of change of density at this portion. The speaker has seen this phenomenon but believes that further work is necessary before definite conclusions can be drawn.

Cotton fiber in polarized Light.

As a result of a splendid series of tests carried out several years ago by Harrison on a number of fibers of different sorts, it was quite conclusively shown that the strains and resulting stresses normally present in rayons of certain types are due to changes in volume (and density) during manufacture, and that subsequent changes in external strain conditions result only in changes of shape. His work was a study of certain fibers in the presence of compressive stresses moisture, and heat. The results are qualitative, but show that there is considerable hope for ultimate quantitative analysis. It is proposed to design and build at M.I.T. a textile micromanipulator which will allow of both compressive and tensile as well as torsional strain conditions to be investigated by polarized light. This may result in a modified form of photo-elastic analysis which will open the way to work of very great importance in textile physics and chemistry.

As you will see by the pictures on the screen, direct color photomicrography has a decided place in the recording of observations by polarized light—which are largely colorimetric. The improved plates which are now available, together with the use of the petrographic microscope and greatly improved sources of illumination, combine to make this a practical technique. Incidentally the designer and colorist should find considerable food for thought in the study of color effects, patterns, and modulations of shade as seen through the polarizing microscope.

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Walter J. Mayer, boss dyer, Utica Willowvale Bleaching Co., Chadwicks, N. Y. Sponsors: L. A. Olney and H. C. Chapin.

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Leroy G. Stolz, president and manager, Wm. G. Stolz Sons., Inc., Butler St. and Belt Line R. R., Reading, Pa. Sponsors: W. A. Stringfellow and Wm. H. Stolz.

Leonard S. Farr, assistant superintendent, Farr Alpaca Co., Holyoke, Mass. Sponsors: A. J. Midwood and H. R. Davies.

January Meeting Northern New England Section

The Northern New England section met at Riverbank Court Hotel, in Cambridge on Saturday evening January 9, with attendance of 63; following dinner at which 46 were present.

Norman Macbeth, President of the Macbeth Daylighting Corporation, spoke on Color Matching under Artificial Daylight, showing a large number of lantern slides, color matching lamps in operation, and glasses used in manufacture of color screens. Under a new system of sharing responsibility for programs, instituted by Henry Grimes as chairman, this program was arranged by Roland Derby.

Respectfully submitted,

HAROLD C. CHAPIN,
Secretary.

ASSOCIATION BADGES

The lapel button badge illustrated herewith is worn by members of the American Association of Textile Chemists and Colorists.

The three "rings" are enameled in red, yellow and blue, respectively, and the initials and border are brought out in gold. The general effect is exceedingly attractive.

Badges may be secured at $1.50 each by addressing the Secretary.

A. NEWTON GRAVES,
Franklin Process Co.,
Providence, R. I.

AMERICAN DYESTUFF REPORTER

Devoted to the use and application of dyestuffs and the mechanical equipment incidental thereto.

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Professor of Chemistry and Dyeing, Lowell Textile Institute
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REDUCING RESEARCH

SEVERAL years ago there were operated in New York City a half dozen or more laboratories for the benefit of certain rayon companies. A few weeks ago there were only two of them still in existence. Now one of these has been closed up and the personnel of the other has been so greatly reduced as to seriously detract from its value. These laboratories were, in most cases, set up in connection with the sales offices, and served as a rapid means of trouble diagnosis. They were not primarily intended as research departments but they were indispensible to the sales department.

The main body of the research work was done by plant chemists, that is, chemists who were employed at the laboratories maintained at the rayon plant. About half of these chemists, and in some cases, more than half of them, have been discharged. In short, the chemical factor in rayon manufacture has been seriously affected. Other than the effect it has on the manufacture of rayon it is increasing the number of trained and experienced chemists who are unemployed.

This condition has, of course, been brought about in an effort to reduce operating expenses in order to reduce losses or show a profit. There have been curtailments in other departments as well. But it seems strange that an industry, whose very existence was brought about by the work of the chemist, should bring about such a wholesale reduction in the staffs of their laboratories. Chemists are still needed in the rayon industry. Although its process of manufacture has been known for a long time it is not yet perfected. The future of the industry lies in the chemist's work.

It is also noticeable that the sales force has been decreased but little in comparison with laboratory staff. Selling is of importance in any establishment that has products of which to dispose. But in a chemical industry should the sales department be maintained while the chemical department is drastically reduced or abolished altogether? The salesmen can only sell what they are given. They can not bring about any improvements in its properties or process of manufacture. Would it not be wiser to maintain the laboratories until the product is more salable? Let the chemist give the salesman a better product.

Such a predicament has nearly always been the lot of the chemist. When money is plentiful or immediate results are forthcoming employers are willing to spend money for research, but when nickels must be pinched or a great deal of time must be spent in order to produce a worthwhile report, the chemist is out of luck and oftentimes a job. Perhaps it may be the fault of the chemical profession itself. Probably they are not widely trained enough to make themselves invaluable to the employer in other ways than as a straight chemist. Perhaps we need more chemist economists. As observed by J. N. Taylor in *The Chemist*, we read:

"Obsoletion and over production may, perhaps, be caused by lack of complete correlation between chemical research and distribution methods. This statement is not to be interpreted as intimating that research should wait upon demand, for fundamental research, of course, must go on. Chemistry, while engaging in an industrial cooperative program, must not neglect pure science. The question arises, then: How much of an interest should the chemist evidence in general economics? How far should he concern himself with specific economic problems of the day? Surely, the average chemist should be sufficiently interested in them to be able to discuss in an intelligent manner the signs of the times.

"As previously pointed out by the writer and by Moraw, this need for a more intensive knowledge of economic conditions as they affect the chemical industry, has already evolved a new kind of chemist, one possessing both chemical and commercial training. But a beginning only has been made in this direction. Every worker in the vineyard should give some time and thought to the interrelationship of science and business. More trained chemist-economists should be in the councils of industry's planning boards. True, the present-day worker has little to say in planning industrial projects, but this is because few matters are decided by the haphazard will of the individual. As observed by Weidlein and Hamor, industrial organization is devised to reduce waste and losses caused by mediocrity and is not contrived to prevent or hinder expansion of ability. Hence, it is imperative that those of our profession who direct the efforts of research chemists and of control chemists should be able to recognize current movements when they see them and to have an awareness of what present progress presages for the future. Laboratory and plant directors must know definitely what researches to pursue, what projects to initiate, and what discoveries to apply or to hold in abeyance. Scientific management, as Bass has pointed out, is vitally important

and must have available economic surveys of the industries. Means of insuring for the chemist stability of employment and continuity of effort through adjustment of production to consumption may well be approached through the avenue of merchandising research. A set-up composed of chemist-economists operating in the domain of economics in a manner analogous to the referee work carried on by the Association of Official Agricultural Chemists in the field of chemistry would in a few years be productive of wonderful results.

"In this connection the meetings recently held in New York, Washington, and several other large cities looking toward the formation of the American Marketing Society are of especial significance. The object of the Society, as stated in its provisional constitution is 'the advancement of science in marketing by providing for the systematic study and discussion of marketing problems and the formulation of standards or principles in this field.' Chemists eligible for membership should by all means seek affiliation with this organization.

"After all is said and done, an outstanding service the chemists can render his profession is through the solution of problems lying broadly in the field of distribution."

NEW PATENTS

(*Abstracted by Synthetic Organic Chemical Mfrs. Assn.*)

Azo Dyestuffs. (The diazo compound of 1-amino-3.4-dimethylbenzene halogenated in 6 position when coupled with the 5-chlor-2-methoxy-1-analide or the 2-methoxy-1-anilide or the 2.5-dimethoxy-1-anilide of 2-hydroxy-naphthalene-3-carboxylic acid; yield, azo dyestuffs dyeing bright neutrally red to bluish-red tints of extremely good fastness to kier-boiling and to light.) Hans Heyna and Erwin Thoma, of Frankfort-on-the-Main-Hochst, Ger., assignors to General Aniline Wks., Inc., of N. Y., N. Y., No. 1,836,118, December 15, 1931.

Monoazodyestuffs. (Obtained by diazotizing 5-acetamino-2-amino-1.4-dimethoxybenzene and coupling with the sodium salt of 1-acetamino-8-hydroxy-naphthalene-3.5-disulfonic acid in aqueous pyridine. Dye wool from an acid bath clear even reddishblue shades of good fastness to carbonization, light, washing and hot-pressing.) Wilhelm Neelmeier and Eugen Glietenberg, of Leverkusen-on-the-Rhine, Ger., assignors to General Aniline Wks., Inc., of N. Y., N. Y., No. 1,836,182, December 15, 1931.

Vat Dyestuffs and Intermediate Products and Process of Making Same. (Obtained by treatment of a benzanthrone with oleum, fusion of the sulfonic acids thus obtained with caustic alkalies and alkylation of the resultant vat-dyestuffs with alkyl-esters of aromatic sulfonic acids, yielding red-violet vats and dyeing cotton gray-blue tints particularly fast to chlorine.) Bertram Mayer, Karl Krauer, and Hugo Siebenburger, of Basel, Switzerland, assignors to Society of Chemical Industry in Basle, of Basel, Switzerland, No. 1,836,859, Dec. 15, 1931.

Palatine Fast Black WAN Extra

The General Dyestuff Corporation sends out circulars illustrating their Palatine Fast Black WAN Extra, a new representative of their Palatine Fast Color class which is said to stand for very good fastness to light, washing, milling and salt water.

Employment Bureau

For the past twenty years the Chemists' Club, with headquarters at 52 East 41st Street, has operated an Employment Bureau to act as a clearing house for the employment of chemically trained men and women throughout the country. It is recognized by the leading organizations of the chemical industries in the United States. Its register at the present time contains applications from men and women of every kind and degree of experience and training in chemical work. The records kept by the Bureau of the training and experience of these applicants are exceptionally complete and include opinions of their respective abilities obtained from former employers. The Bureau offers to the readers of this journal every possible help in obtaining the services of chemists.

New R & H Booklet

The uses of Sodium Perborate are discussed in a new booklet of the Roessler and Hasslacher Co. of New York entitled "Properties and Uses of R & H Sodium Perborate." The discussion of its uses in the textile industry includes: oxidation agent for vat colors, bleaching, light scouring of cotton previous to dyeing, detergent assistant, stain remover and antichlor for use after hypochlorite has been employed. The stability of the compound is cited as one of its advantages. Copies of this booklet may be obtained from the manufacturers.

In Charge of Sales

The Norwood Engineering Company, general offices and works, Florence, Mass., has just appointed W. C. Hanson in charge of sales in the New York Metropolitan District for their line of industrial and municipal filters and accessories.

Mr. Hanson, who has been and will continue to be their Export Manager, is located at 50 Church Street, New York City.

Fast Corinth LB Base

The General Dyestuff Corporation is placing on the market Fast Corinth LB Base, a new Fast Color Base which, in combination with most of the Naphthols of the AS range, is said to yield very fast reddish to bluish shades which are somewhat brighter than those obtained with Fast Corinth Salt V Conc.

Benefits of pH Control

By **BENJAMIN LEVITT, F.A.I.C.**

Much has been written on the subject of Hydrogen Ion control but this system of measurement has as yet not received as much consideration by industry in this country as abroad, although considerable progress in that direction has already been made.

THOSE who are making use of the Hydrogen Ion system of controlling chemical processes, have found it an invaluable aid in standardizing alkalinity or acidity. In other words, having once noticed that a certain solution or emulsion has given a desired effect, it is possible to duplicate this result, if the pH of the solution in hand is determined, and if all repeats are made up to the same pH. The measurement is quick and accurate besides, no great skill is necessary on the part of the operator. He can learn to make determinations accurately in a few minutes.

What is the meaning of Hydrogen Ion Concentration, or pH, as it is usually expressed? First, let us briefly review the constitution of matter.

Matter is defined as anything which occupies space. Therefore, anything whether a gas, liquid or solid, is known as matter. All matter or substance consists of molecules. A molecule is the smallest division of matter that has the properties which characterize that substance. For instance, if we could isolate one molecule of water, we would find under examination, that it consists of two molecules of hydrogen and one molecule of oxygen. Now if we go a step further and break up the molecule, we will then have decomposed thes ubstance into its elements, namely, hydrogen and oxygen.

Until comparatively few years ago, the atom was believed to be the smallest subdivision of an element. However, investigators have pointed out that within the atomic structure there exists positive electrical charges known as protons, and negatively charged portions called electrons.

No matter from what element these corpuscles may be derived, they are said to be the same size. Furthermore, these electrical units are bombarding one another within the atom and in that way control the behavior of the atom as well as to impart other properties.

Under certain conditions an atom may be deprived of one or more electrons. The remainder of the atom thereupon becomes a positively charged ion. Atoms may also acquire more electrons and thus become negatively charged ions.

It is the attraction of some positively charged ions for those with a negative charge which results in the formation of compounds. The positive charges of ions can be measured by means of a potentiometer. This is the basic instrument by which all other systems of pH measurements are calibrated.

The theory of electrolytic dissociation propounded by Svante Arrhenius, states that when an acid (or salt) goes into solution some of its molecules become split up into positive and negative ions. It is this proportion of ionized hydrogen that determines the degree af acidity. Basic properties of alkaline solutions are due to the presence of hydroxyl (OH) ions, and their concentration determines the degree of alkalinity.

Prof. Sorensen, the great Danish chemist, proposed the method of expressing hydrogen ion concentration now in general use. As expressed numerically, for a neutral solution, the concentration of hydrogen ions is 1/10,000,000, which is a rather awkward way of putting it. Sorensen, therefore, proposed that the logarithm of the reciprocal of that number be used.

pH Strength

This number he termed the pH, which is 7 for a neutral solution at 22 degrees C. Acid solutions vary in strength from 7 to 0—; the strength of the acid increasing from 7 down to 0. Alkaline solutions increase in strength from 7 to 14. It should be noted that the pH increase slightly as the temperature is elevated.

McCrumb formerly of the LaMotte Chemical Products Company, and now chemical director of W. A. Taylor & Company gives the following figures for N/10 solutions:

Acids	pH
Hydrochloric	1.0
Sulphuric	1.2
Phosphoric	1.5
Acetic	2.9
Boric	5.2

Dilution of these chemicals does not alter the pH very materially.

J. G. Vail gives the following pH strengths for 1/10 per cent solutions of the various alkalies noted:

Alkalies	pH
Caustic Soda ($NaOH$)	11.8
Sodium Metasilicate ($Na_2O.SiO_2.5H_2O$)	11.2
Trisodium phosphate ($Na_3PO_4.12H_2O$)	10.9
Soda Ash (Na_2CO_3)	10.7
Sodium sesquicarbonate ($Na_2CO_3.NaHCO_3.2H_2O$)	10.0

There are certain salts which give acid reactions. The most common are Mono sodium phosphate (NaH_2PO_4), Potassium alum ($Al_2(SO_4)_3.K_2SO_4.24H_2O$) Stannous chloride ($SnCl_2$).

By mixing an alkali (or an acid) of certain pH with an acid salt (or alkaline salt) it is possible to obtain solutions of any pH that we may desire. The action of these salts in toning the pH of the solution is called "buffer action," and the agency by which it is accomplished is known as a "buffer."

The following chart prepared by W. A. Taylor & Company shows the indicator, pH and color change:

Indicator	*ph Range*	*Color Change*
Acid Cresol Red	0.2-1.8	Red-Yellow
Thymol Blue	1.2-2.8	Red-Yellow
Alpha Dinitro-phenol	2.8-4.4	Colorless-Deep Yellow
Bromcresol Green	3.8-5.4	Yellow-Blue
Methyl Red	4.4-6.0	Red-Yellow
Bromthymol Blue	6.0-7.6	Yellow-Blue
Cresol Red	7.2-8.8	Yellow-Red
Thymol Blue	8.0-9.6	Yellow-Blue
Phthalein Blue	8.8-10.4	Yellow-Blue
Tolyl Red	9.6-11.2	Purple-Red
Parazo Orange	11.0-12.6	Yellow-Orange
Acyl Blue	12.0-13.6	Red-Blue

The Eastman Kodak Company has prepared a chart of Eastman Organic Chemical indicators showing the color ranges of all indicators which they manufacture. Those who are interested may obtain this chart free of charge from Eastman Kodak Company at Rochester, New York.

Standardized Sets

For those who do not know the exact pH at which they are working we might recommend that they submit the solution to an apparatus supply house who will be glad to make the determination for them, and so be in a position to recommend the proper pH standards which will fall into the category of that particular solution.

The most accurate method for the determination of pH is by means of the potentiometer. This instrument is made in several forms, depending on the purpose for which it is intended. For research work, requiring great precision, there is a type of potentiometer which is accurate to 0.002 pH. The pH recorder is an instrument which furnishes a continuous record of acidity or alkalinity of a solution.

It may be used to operate signalling or control contacts. Such a device has practical application in the mill for regulating the alkalinity of mercerizing solutions and for acid neutralizing baths. The various types of these electrical devices are adequately described in Leeds & Northrup Company's catalog No. 75.

Using the above described instruments as the standard a number of devices have been invented employing various color reagents with which colors of unknowns may be compared and so determine the pH very quickly.

In most of these systems tubes or ampules containing buffered solutions accurately standardized for definite pH range are used in a block called a Comparator. To an equal volume of the unknown solution one-half c.c. of the indicator for the particular range expected, is added. It is then compared with the standard which matches it closest.

If one wishes he may make up a set of standards to his own needs by following the method outlined in "The Determination of Hydrogen Ions" by W. M. Clark, published by Williams & Wilkins Company, Baltimore, Md., 1928. However, after spending much time and considerable money for these makeshift devices the operator will conclude that it pays to buy a set that is accurately standardized. These color comparator sets are said to be accurate for at least one year.

The LaMotte comparator consists of sets of sealed vials, or standards, which are placed in a block and used to match an unknown containing the same color reagents that have been used in the standards.

The Taylor comparator is somewhat similar to the above but the standards are set into cases made of bakelite. Each ampule, therefore, does not need to be removed to make the test. This avoids the possibility of breakage.

The Wulff comparator is entirely different than the preceding devices in that the standards consist of chemically treated celluloid strips impregnated with the color standards. These are immersed in the liquid unknown to be tested. Any excess solution may be blotted off and the strip is then compared with the standard colored strips enclosed in glass. The pH is read directly from the matched strip.

Useful in All Stages

The Hellige comparator, instead of having vials as standards, uses wheels containing sets of colored glass discs. The disc of the approximate pH is set into a block containing graduated test tubes for holding the unknown solution. Readings, according to the manufacturers, can be made that are accurate to 0.1 pH.

pH determinations will be found useful in all stages of silk preparation.

In the soaking bath the alkalinity of variously prepared emulsions may be noted with a view to obtaining the proper emulsion for the optimum effect. The emulsion may be tested for any change that may occur after soaking. Interesting light may be thrown on chemical changes in samples of spent emulsions upon storing for some time afterwards. We have noticed that some such samples submitted to the writer's laboratory putrified soon after their receipt, while others were received in a partly decomposed condition. We may therefore, reason that if the spent emulsion putrifies, that part of it which is left on the silk may be affected in the same fashion. Here is a chance for investigation and remedy.

In weighting, dyeing, scouring and in fact all stages of treatment; pH studies will throw valuable light on the efficiency of the process.

The Outlook for the Export Trade in American Dyestuffs

(*Continued from page 36*)

TABLE III

United States Exports of colors, dyes, and stains (inclusive of package dyes for household use)

Country of Destination	1929		1930		1931*	
	Pounds	*Value*	*Pounds*	*Value*	*Pounds*	*Value*
China	24,528,049	$3,217,746	19,409,852	$2,467,896	11,911,423	$1,636,639
Japan	1,806,931	1,055,432	1,314,756	776,937	1,232,731	711,252
Canada	1,911,967	972,012	1,869,965	903,028	1,410,135	647,195
British India	1,488,850	636,634	1,446,048	632,578	849,253	352,234
Belgium	1,594,148	340,430	1,197,631	319,770	368,614	92,370
Germany	469,754	228,246	538,460	104,301	462,381	90,645
Mexico	197,115	81,824	250,969	117,998	159,694	78,169
Soviet Russia in Europe	67,247	55,236	94,986	84,543	14,394	9,600
Other countries	2,066,263	691,526	2,144,673	838,779	1,431,440	489,949
Total	34,130,324	$7,279,086	28,267,340	$6,245,830	17,840,065	$4,108,053

*10 months.

United Kingdom Dyestuffs (Import Regulations) Act of 1930 to December 31, 1932. The present Act expired December 31, 1931. The Act prohibits the importation, except under license issued by the Board of Trade, of all synthetic organic dyestuffs, colors and coloring matters and all organic intermediate products used in the manufacture of any such dyestuffs, colors and coloring matters. Under a revised ruling adopted in January, 1931, import licenses will be granted if British makers are not willing to supply dyestuffs at the foreign prices, provided these are not "dumping" prices, defined as prices below which foreign makers are selling the products in other countries.

Interest for U. S. dyestuffs producers in Great Britain, what with its new tariff, abandonment of the gold standard, etc., must be paralleled by curiosity as to future trade sentiment in the Dominions and the effect of the renewed efforts to cultivate inter-Empire trade by means of preferential concessions of one kind or another. With Canada ranking as the second or third best customer of the American dyestuffs industry it is impossible to ignore the growing unrest in Canada over the exchange situation. If Canadian customers continue to be called upon to pay $1.15 or so for an American dollar the effect, according to predictions in well-informed circles in Canada. will be to divert a certain proportion of the orders for dyes to other supply channels.

TABLE IV

Coal Tar Dye Imports into India

	—Alizarine Dyes—		*—Aniline Dyes—*	
	1929-30	1930-31	1929-30	1930-31
	Pounds	*Pounds*	*Pounds*	*Pounds*
United Kingdom	1,405,000	724,000	990,000	821,000
Germany	3,585,000	2,369,000	9,171,000	9,494,000
United States	76,000	107,000	1,511,000	1,156,000
Netherlands	213,000	1,000	81,000	23,000
Switzerland	49,000	40,000	707,000	487,000
Belgium	.....	.....	55,000	59,000
Other countries	.....	.....	804,000	779,000
Total	5,328,000	3,241,000	13,319,000	12,819,000

Synthetic indigo was also imported to the quantity of 1,120,000 pounds mostly from Germany and Switzerland.

In conclusion it may be noted that just so surely as the exchange rate will play some part in the export dyestuffs destiny of 1932 is it certain that an even larger part will be played by terms of credit. It has lately come to be realized that one of the secrets of Germany's success in the face of the depressed conditions of the past few years is to be found in the spirit of extreme accommodation shown with respect to credits. Germany's low quotations

TABLE V

Exports from the United States of Coal Tar Colors, Dyes, Stains and Color Lakes: January-June, 1931, by Countries of Destination.

	Pounds	*Value*
Belgium	210,809	$52,640
Czechoslovakia	21,880	8,299
Denmark	4,290	1,291
Finland	1,495	151
France	34,286	19,022
Germany	387,204	76,579
Greece	14,210	7,818
Hungary	280	113
Iceland	14	26
Italy	27,830	9,577
Netherlands	221,268	37,040
Norway	550	176
Poland and Danzig	1,410	1,417
Soviet Russia in Europe	14,394	9,600
Spain	20,136	13,944
Sweden	15,506	6,071
Switzerland	16	16
United Kingdom	4,549	6,106
Canada	845,940	372,061
British Honduras	135	165
Costa Rica	2,013	1,930
Guatemala	558	438
Honduras	173	108
Nicaragua	96	81
Panama	4,284	2,649
Salvador	187	422
Mexico	89,067	49,850
Newfoundland and Labrador	7,893	6,080
Bermudas	87	71
Barbados	522	216
Jamaica	2,412	799
Trinidad and Tobago	234	128
Other British West Indies	124	55
Cuba	27,645	16,631
Dominion Republic	1,001	1,002
Netherlands West Indies	362	143
Haiti	569	359
Argentina	59,295	21,492
Bolivia	15	42
Brazil	47,079	16,305
Chile	51	72
Colombia	6,639	4,416
Ecuador	6,612	3,372
British Guiana	1,435	659
Paraguay	24	32
Peru	5,951	3,420
Uruguay	6,737	2,661
Venezuela	7,255	5,299
Aden	2,240	224
British India	699,157	303,838
British Malaya	578	626
Ceylon	15,906	1,776
China	8,058,621	1,127,407
Java and Madura	51,397	6,678
Other Netherland East Indies	950	643
Hong Kong	123,142	32,011
Japan	710,773	426,764
Philippine Islands	34,214	6,135
Syria	2,200	550
Turkey	100	63
New Zealand	7,008	6,180
British East Africa	1,120	112
Union of South Africa	5,715	3,112
Totals	11,817,544	$2,676,963

have been potent, of course, but matching the low prices in persuasiveness, are the long credits granted. The need for the best possible American strategy in formulating credit policies lends weight to the suggestion of Mr. J. N. Taylor, Dyestuffs Expert of the Chemical Division of the Department of Commerce, that chemists should participate actively in the marketing studies of the recently organized American Marketing Society.

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i.e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

POSITION WANTED

RAYON AND COTTON DYER—Skein dyer, all types of dyes. Ten years' thorough experience. Technical college graduate. Perfect matches. Reasonable salary. Address Box No. 708, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

POSITION WANTED

Textile Chemist and Colorist with ten years' practical experience, being available, solicits inquiries. Address Box No. 710, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

FINISHER WANTED

Finisher wanted with experience in handling silk, also silk and Celanese mixtures. Must have good experience. Address Box No. 712, American Dyestuff Reporter, 440 Fourth Avenue, New York.

WANTED

Wanted: Man with experience in boarding and examining circular knit hose. Some knowledge of dyeing an advantage. State age, experience and remuneration expected. Address Box No. 713, American Dyestuff Reporter, 440 Fourth Avenue, New York.

DYER REQUIRED

with good boil-off experience to handle sheer silk, also silk and Celanese mixed fabrics. State age and experience. Address Box No. 714, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

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